STATE OF COLORADO

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DIVISION OF MINERALS & GEOLOGY
RECLAMATION MINING • SAFETY

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Michael B. Long
Division Director

MAR 2000
RECEIVED

February 25, 2000

Mr. Dan Beley
Colorado Department of Public Health & Environment
Water Quality Control Division
4300 Cherry Creek Drive South
Denver, Colorado 80426-2000

RE: Final Report - Contract # WQC9807035 Animas River Targeting Project, Upper Animas

Dear Mr. Beley:

Enclosed is a revised final report on the Upper Animas River (Animas above Eureka) portion of the Animas River Targeting Project. I have attached an unbound copy of the technical report and approved SAP. Hopefully this format meets with the needs of Region VIII EPA.

If you need any further information, please do not hesitate to give me a call.

Sincerely,

Jim Herron

Jim Herron
Project Manager

SECTION 319 NONPOINT SOURCE POLLUTION CONTROL PROGRAM
WATERSHED PROJECT FINAL REPORT

ANIMAS RIVER TARGETING PROJECT
ANIMAS RIVER ABOVE EUREKA

By

Jim Herron
Colorado Division of Minerals & Geology
February, 2000

This project was conducted in cooperation with the United States Environmental Protection Agency, Region VIII and the State of Colorado

Grant # WQC9807035

EXECUTIVE SUMMARY

PROJECT TITLE: Animas River Targeting Project – Animas River Above Eureka

PROJECT START DATE: August, 1997

PROJECT COMPLETION DATE: October, 1999

FUNDING:

TOTAL BUDGET:	$75,316.67
TOTAL EPA GRANT	$45,190.00
TOTAL EXPENDITURES OF EPA FUNDS	$45,180.76
TOTAL EXPENDITURES	$45,180.76
REVISIONS	$0
TOTAL SECTION 319 MATCH ACCRUED	$30,152.00

SUMMARY ACCOMPLISHMENTS

Water quality sampling and loading analysis were completed for high-flow and low flow on the Animas River above Eureka. A reclamation feasibility report was produced, outlining how water quality can be approved.

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APPENDICES

Animas River Targeting Project
Animas River above Eureka

Introduction

The Animas River Targeting project was initiated by the Water Quality Control Division (WQCD) in 1994. WQCD collected water quality samples in selected areas of Mineral Creek, then subcontracted with DMG to write a reclamation feasibility report. Following reorganization at WQCD in 1996, DMG became the project sponsor for the Cement Creek portion of the Animas River Targeting Project. Cement Creek was followed by the Animas River above the townsite of Eureka. DMG is currently working on the report for the Animas River between Eureka and Silverton.

The grant for this project originated as a grant for the Cement Creek Project. The original Nonpoint Source grant request was in the amount of $96,200 to collect site specific water quality information in Cement Creek. Because of insufficient funds, only 95% of the grant or $91,390 was available. In early 1996, Region VIII EPA agreed to analyze the water quality samples in their laboratory. With EPA paying for the laboratory analyses, a contract amount of $46,200 was negotiated for Cement Creek. This left $45,190 left in the original grant, which was applied to the Upper Animas.

Reconnaissance investigations to determine which sites should be sampled were done in August, 1996 and August 1997. Mine waste sampling was done during August 1997. Water quality samples were collected during the low-flow period in September 1997. Water quality samples were collected during the high-flow period in July 1998. In January 1999, DMG began data analysis and report writing. The report on the investigations was completed in October 1998. A copy of the report is attached as Appendix 1.

A total of $45,180.76 was expended to complete this project. The majority of the budget was spent on personnel time for DMG employees. The principle investigators included Jim Herron, Bruce Stover, and Paul Krabacher. Activities funded by this grant included Reconnaissance investigations, preparation of sampling plan and EPA ULSA lab requests, procurement of water sampling equipment, water sampling, mine waste sampling, data analysis, and report writing. The budget table below breaks down the expenditures into major categories.

Expenditure	**Amount**
Personnel	$31,550.73
PERA	3,375.02
Travel	1,209.24
Printing	1,999.57
Laboratory	1,162.14
Sample Shipping	502.50
Sample Bottles and Equipment	2,072.53
Indirect Cost	3,309.03
Total Expenditures	$45,180.76

The above costs were part of six tasks in Exhibit C of the contract. An estimated breakdown of the cost by the three tasks is given below:

Budget Item	Budget Estimate	Actual Expenditure	Match
Field Surveys	$15,000.00	$11,409.00	$ 4,224.00
Water Quality Sample Collection	$ 4,000.00	$ 5,983.00	$11,633.00
Metals Loading Analysis	$ 4,500.00	$ 4,700.00	$ 990.00
Preliminary Site Feasibility Plans	$10,000.00	$11,226.76	$ 4,308.50
Mine Site Prioritization	$ 5,500.00	$ 5,900.00	$ 1,417.50
Mining Waste Sampling and Analysis	$ 6,190.00	$ 5,962.00	$ 7,579.00

Project Goals, Objectives and Activities

The overall goal of this project was to collect site enough water quality data to allow the Animas River Stakeholders Group to prioritize the source sites, and to collect enough site specific information on those sites to determine appropriate remediation methods.

Planned and Actual Milestones, Products and Completion Dates

The following table illustrates the milestones, products, and completion dates. Because a contract was not issued by the Colorado Department of Public Health and Environment until August of 1997, some of the dates for milestones were revised.

Milestone	Output	Planned Completion	Revised Completion	Actual Completion
Conduct Field Surveys of Sites in Identified Loading Areas	Sampling and Analysis Plan	10-97	10-97	8-97
Collect Water Quality Data from Specific Identified Sites	Samples Collected	11-97	7-98	7-98
Analyze Data	Water Quality Data	11-97	7-98	1-99
Identify Site Specific Loads	Loading Report	6-98	12-98	4-99
Field Survey to Determine Control Measures	Site Data	9-98	9-98	8-98
Engineering and Economic Analysis of Sites for Control Measures	Remedial Plans	10-98	6-99	10-99
Prioritization of Sites for Control Measure Implementation	List of Priority Sites	10-98	6-99	5-99 (Process On-going)

Evaluation of Goal Achievement and Relationship

The final report on these investigations was delayed for two reasons: 1) The scope of this project was significantly increased; and 2) The grant monies were not received until later than anticipated. The original scope of the project included only the area above the townsite of Animas Forks. The ARSG requested that all significant mining sites above the Eureka townsite be included in the study, which doubled the number of sampling sites. The project had one goal:

Goal 1: The goal of the targeting project is to provide in depth identification, water quality information, technical and economic feasibility, and prioritization of specific sites for improvement of water quality in the Animas River above Eureka.

There are two objectives under Goal #1:

Objective 1: Determine specific sites to be considered for prioritization.

Objective 2: Determine the remediation and economic feasibility for ten priority sites.

Both objectives were achieved during this project. In fact, more than 10 sites, as required in objective 2, were characterized for economic and remediation feasibility. A brief discussion of the tasks under each objective follows:

Task 1 of objective 1 was met by conducting reconnaissance investigations of the watershed. During August of 1996. DMG personnel spent about two weeks walking through the various tributaries to determine where potential sources of heavy metals were located. This resulted in the sampling plan which is attached as Appendix 2.

Task 2 of objective 1 was met by sampling the Upper Animas, major tributaries, draining mines, and mining wastes. The site locations are shown in Appendix 1.

Task 3 of objective 1 was met. The water quality samples were delivered to EPA laboratories. Leachate extracts from the mining wastes were analyzed by the Colorado School of Mines.

Task 4 of objective 1 involved loading analysis to identify the principal sources of heavy metals in the Upper Animas. The final report attached as Appendix 1 contains the loading analysis.

Task 5 of objective 2 was completed before and after water quality sampling, when the heavy metal source sites were visited to determine possible remediation methods.

Task 6 of objective 2 was a major part of the report attached as Appendix 1.

Task 7 of objective 2 is an on-going process. The initial prioritization was delivered to the Animas River Stakeholders Group. Prioritization of the source sites in the Animas River above Eureka is being updated as additional information becomes available.

Supplemental Information

This section does not apply to this grant.

Best Management Practices Developed and/or Revised

BMP Effectiveness Evaluations

This section does not apply to this grant.

Surface Water Improvements

This section does not apply to this grant.

Ground Water Improvements

This section does not apply to this grant.

Other Monitoring

This section does not apply to this grant.

Quality Assurance Reporting

This section does not apply to this grant.

Results of BMP Operation and Maintenance Reviews

This section does not apply to this grant.

Coordination Efforts

Coordination From Other State Agencies

This grant was issued by the Colorado Department of Public Health and Environment. During water quality sample collection, there were several volunteers from CDPH&E. There were also volunteers from the Colorado Geological Survey.

Other State Environmental Program Coordination

This section does not apply to this grant.

Federal Coordination

This project was completed under the guidance of the ARSG. The ARSG includes several federal government agencies, including the United States Geological Survey (USGS), US Bureau of Land Management (BLM), US Forest Service (USFS) Region VIII EPA and US Bureau of Reclamation (BOR). Investigations were coordinated with these agencies to avoid duplication of effort. All these agencies also participated in the water quality sampling.

There was considerable coordination with Region VIII EPA to get the water quality samples analyzed.

<u>USDA Programs</u>

This section does not apply to this grant.

<u>Accomplishment of Agency Coordination Meetings</u>

This section does not apply to this grant.

<u>Resources/Coordination From Federal Land Management Agencies</u>

This section does not apply to this grant.

Summary of Public Participation

A total of $30,130 in match was required for this project. Match documented for the project amounts to $30,152. The match consists of voluntary overtime by DMG employees, the value of volunteers helping with water quality sampling, members of the Herron Family running the field laboratory during waste rock sampling, and laboratory analysis completed by the Colorado School of mines. A breakdown is given below.

Source	Amount
DMG Voluntary Overtime	$ 6,716
Volunteer Time – Water Quality Sampling	$15,857
Herron Family	$ 4,379
Colorado School of Mines – Laboratory Work	$ 3,200

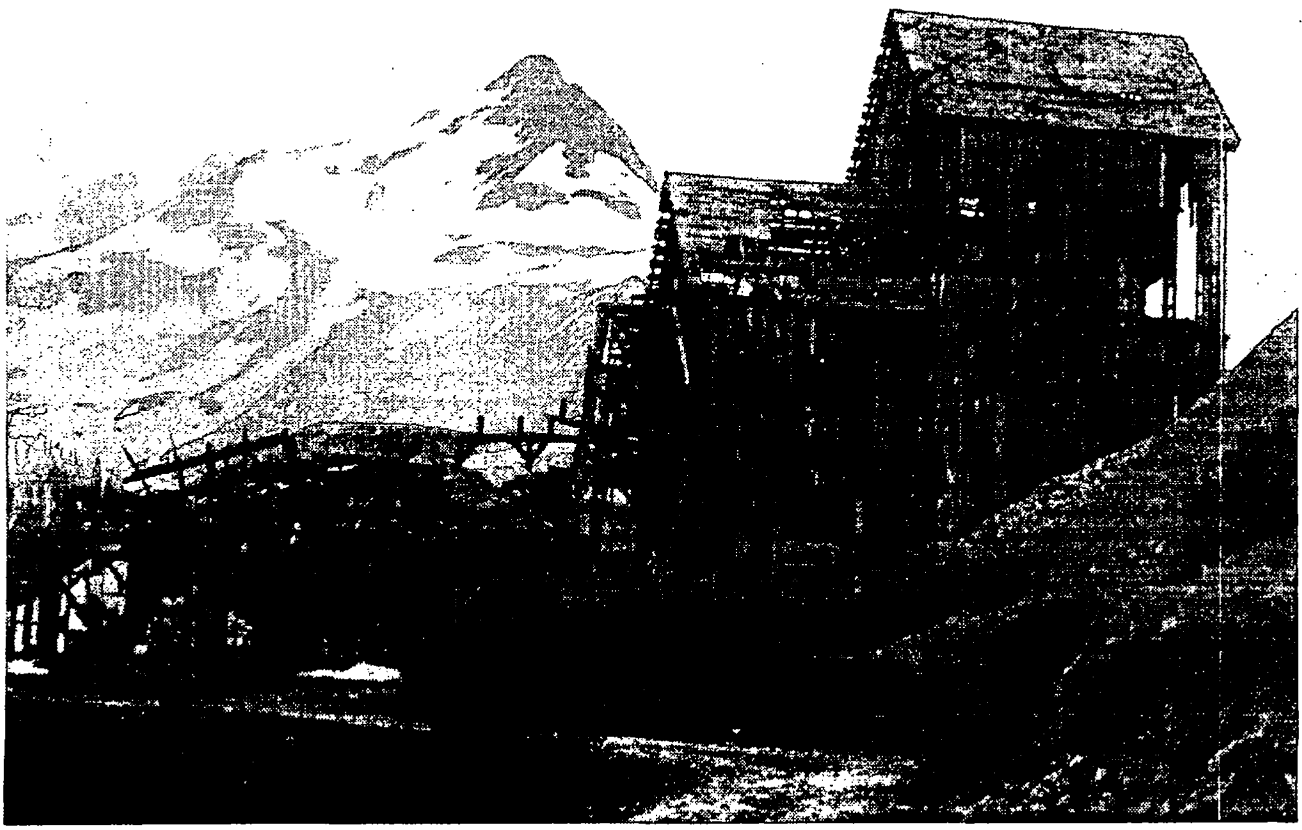
Future Activity Recommendations

This was the second of three subwatersheds to be characterized by the Division of Minerals and Geology. The final report on the Animas River below Eureka is currently underway. Like most scientific investigations, there are some questions that arose following the water quality sampling. These areas where additional work is needed are outlined in the report attached as Appendix 1.

APPENDIX 1

RECLAMATION FEASIBILITY REPORT

ANIMAS RIVER ABOVE EUREKA



JIM HERRON, BRUCE STOVER AND PAUL KRABACHER

COLORADO DIVISION OF MINERALS AND GEOLOGY

OCTOBER, 1999

RECLAMATION FEASIBILITY REPORT

ANIMAS RIVER ABOVE EUREKA

Jim Herron, Bruce Stover and Paul Krabacher

Colorado Division of Minerals and Geology

Funded through Clean Water Act – 319 Grants

Special thanks to the Animas River Stakeholders

October, 1999

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INTRODUCTION

This report is intended to be a guidance document for use by the Animas River Stakeholders Group (ARSG) in prioritizing and planning water quality reclamation projects at mine sites in the Animas River above the townsite of Eureka. The initial reconnaissance investigation of the basin was performed by the Colorado Department of Public Health and Environment, (CDPH&E) Water Quality Control Division (WQCD) in 1991, 1992, and 1993. The water quality samples collected at that time principally bracketed the tributary streams, but did not identify individual sources. Based upon those results, the Colorado Division of Minerals & Geology (DMG) conducted a more comprehensive reconnaissance to formulate a sampling plan for collecting and analyzing water quality and waste rock extract data. The DMG sampling program was conducted in 1997 and 1998 in accordance with this plan and resulted in this reclamation feasibility investigation report. Using the report, the ARSG will prioritize the sites investigated, and plan future reclamation work in the Animas River above Eureka.

It is important to note that this investigation focused only on the metals contributions from surface mine waste and mine portal discharge sources in the Upper Animas River. Although metal loading from groundwater inflows to the streams in the study area is indicated by the analytical results of this investigation, no data has been developed yet to partition these inflows into relative proportions of mining-affected groundwater versus natural sources. Groundwater flow from the mines currently provides an unquantified pathway for metals to enter the streams.

The ultimate goal of this work is to improve the water quality and fisheries of the Animas River downstream of Silverton, Colorado by reclaiming abandoned mine sites upstream of Silverton. To achieve this goal, four reclamation feasibility investigations were planned for the Animas River watershed above Silverton. The first report published in 1997 covered mining sites in the Mineral Creek watershed. The second report published in1998 covered mining sites in the Cement Creek watershed. This report, which covers mining sites in the main stem of the Animas River above the townsite of Eureka, is the third to be published. The final report, which will cover mining sites in the Animas River between Silverton and the Eureka townsite, is scheduled for completion in 2000.

GENERAL SITE DESCRIPTION

LOCATION

The Animas River is located in San Juan County in the San Juan Mountains in southwestern Colorado. The Animas River begins approximately 14 miles northeast of Silverton. Figure 1 is a general location map of the area.

Prospecting began in San Juan County in the 1860's. Mining began in the area in 1874. There are hundreds of inactive and abandoned mines and prospects in the Upper Animas. There are no currently operating mines in the Animas River above Eureka.

Investigation of the water quality of the Upper Animas River was initiated as part of the effort to improve the water quality in the Animas River below Silverton. The Upper Animas was targeted because investigations have shown that there is virtually no fish life in the Animas River above the Eureka townsite, and there is a visual impact from precipitation of heavy metals. Although there are natural sources within the watershed, adit discharge and leaching of waste rock from abandoned and inactive mines contributes to the degradation of water quality.

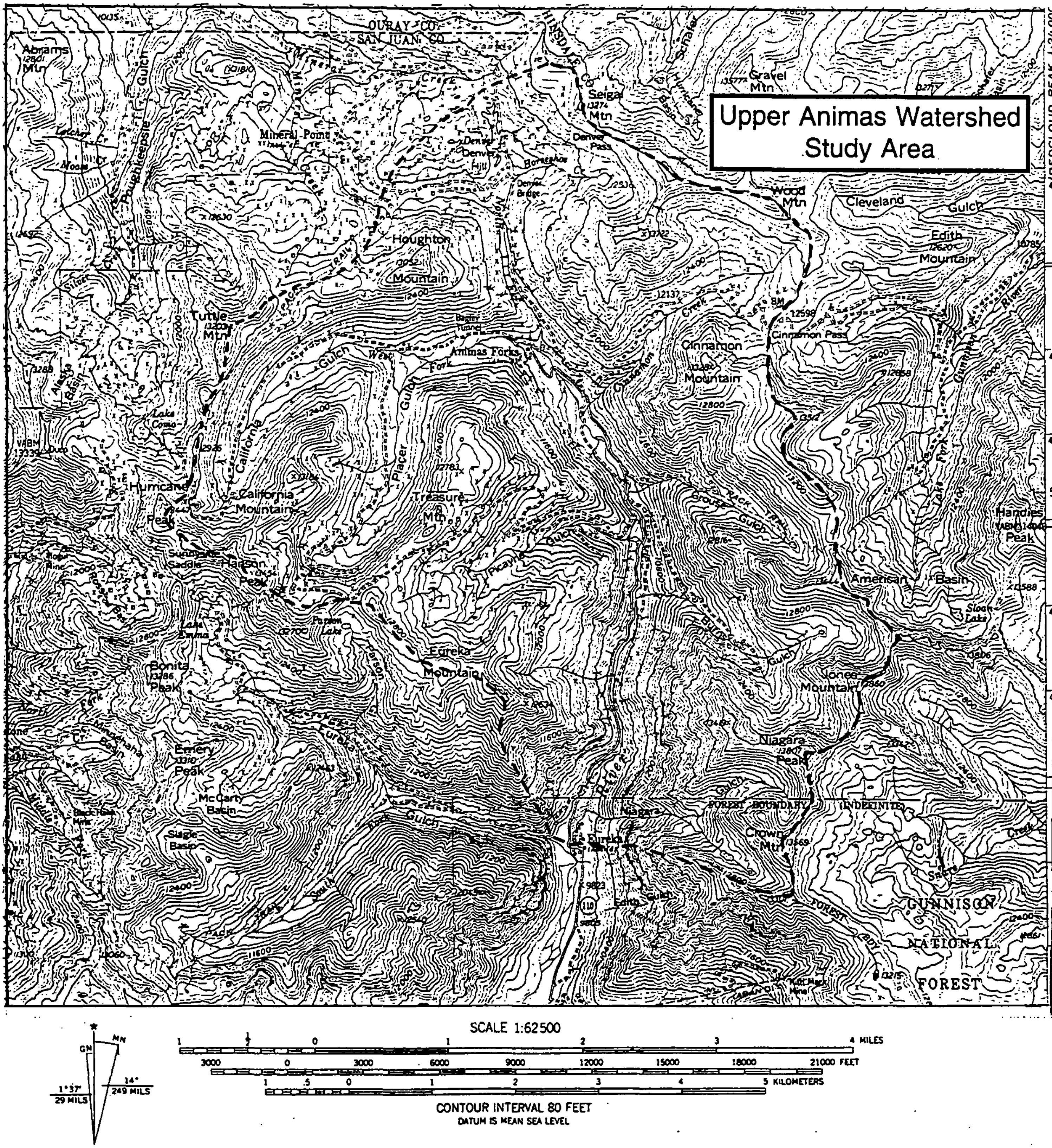


Figure 1: Topographic Map of the Animas River Study Area Above Eureka

GEOLOGY

Water quality sampling in the Upper Animas Basin around Silverton has shown that in-stream water quality can be directly correlated to the specific geologic, mineralogic, and rock alteration attributes present in a stream's watershed. Rock type, primary mineralization suites, and both pre and post-mineralization hydrothermal alteration systems present in a watershed characterize the observed stream water quality, even in undisturbed watersheds. Analytical data shows that the overall stream water quality in the upper Animas watershed is generally much better than the water quality of Cement Creek and Mineral Creek Watersheds. There is a direct association between better in-stream water quality and the geologic differences in mineralization and alteration styles present in the watersheds.

Major rock units and regional structural geology are described in this section of the feasibility report, with detailed geologic descriptions of individual mine sites presented in the site characterization section. A structural geologic map of the Upper Animas River area is shown in Figure 2.

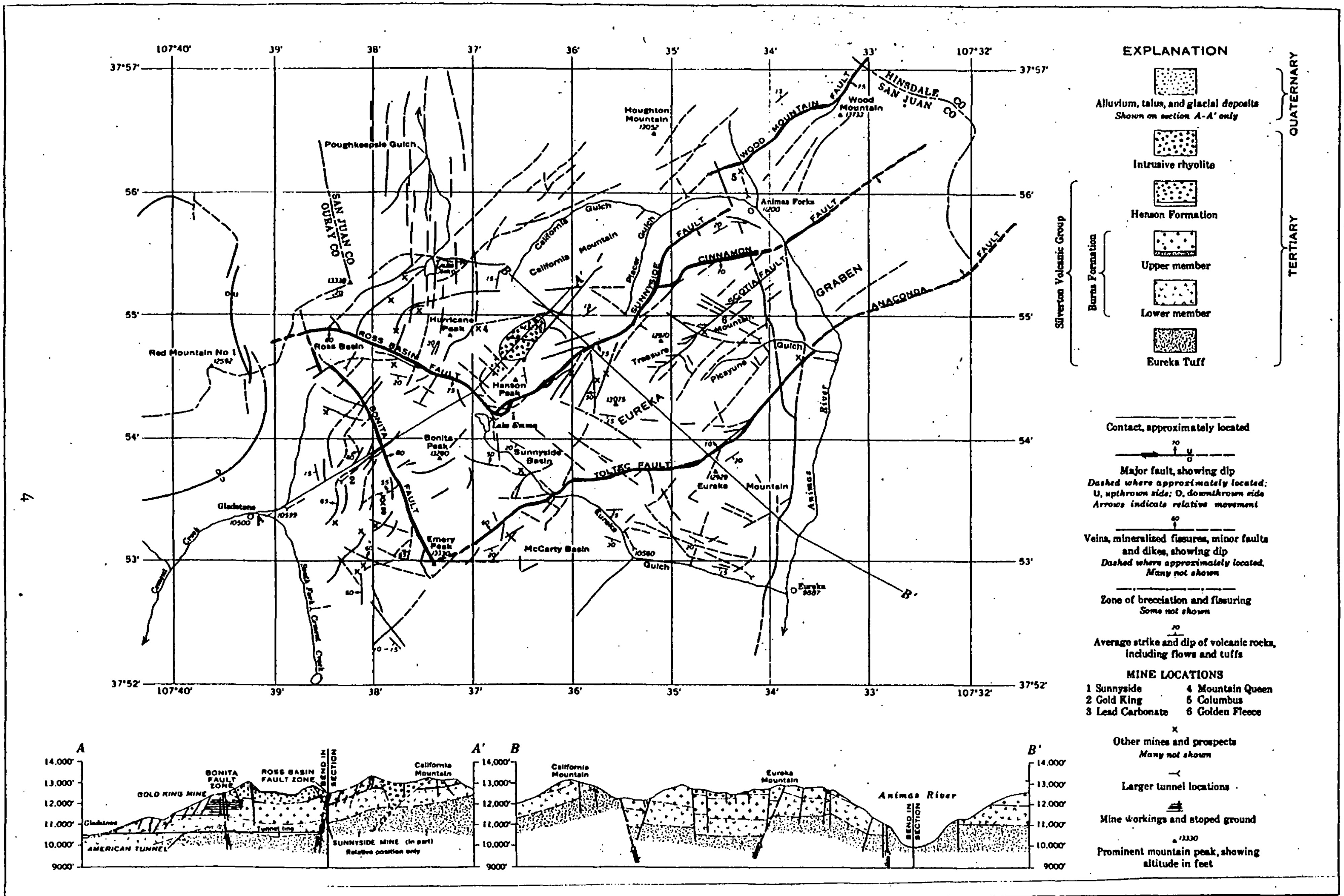
Published geologic mapping is available for the study area. The watershed lies within the Handies Peak 7.5 min. Quadrangle, mapped by R.G. Luedke and W.S. Burbank of the U.S Geological Survey at a scale of 1:24,000, (U.S. Geological Survey GQ-1595). U.S.G.S. Professional Paper 535, by the same authors, also covers much of the study area, and is one of the principal sources for much of the geologic information presented in this report.

The U.S. Geological Survey is completing a new series of age-dates for volcanic rock sequences, and is in the process of re-interpreting the volcanic history of the area (D. Bovey, personal communication, January 1999). Although the overall volcanologic framework and geochronology of volcanic events is subject to change and re-interpretation through the normal refinement of geological understanding, these re-interpretations will not greatly change or affect site-specific geologic characterization of individual mine sites. The descriptions of bedrock, mineralogic, alteration, and structural features of the sites which directly influence water quality and reclamation feasibility are well documented in the literature. Previous U.S.G.S. quadrangle mapping and published descriptions of the rock units in the Silverton Caldera remain excellent sources of geologic data for site characterization.

BEDROCK STRATIGRAPHY

The Upper Animas watershed lies on the northern margin of the Silverton Caldera, a regionally prominent Tertiary-aged volcanic center within the larger San Juan Volcanic Field. Extrusive sequences of volcanic ash-flow tuffs and flow breccias, dacite and rhyodacite lava flows and domes, and intrusions of rhyolite and quartz-latite underlie the area. These rocks belong to the Silverton Volcanic series, and underlying Sapinero Mesa Tuff. The Silverton series has been further subdivided into mapable formations in the Silverton Caldera.

The sequence of volcanic rocks underlying and exposed in the project area are described here, from oldest to youngest (Ludeke and Burbank, 1987):



GENERALIZED STRUCTURE MAP AND GEOLOGIC SECTIONS OF THE EUREKA, ANIMAS FORKS AND GLADSTONE AREAS, SAN JUAN COUNTY, COLORADO

Figure 2. Plate 6 from USGS Prof. Paper 535, Burbanke and Luedke, 1969

Extrusive and Related Rocks

Sapinero Mesa Tuff (Oligocene)

Picayune Megabreccia Member This sequence of fine-grained porphyritic andesite lava flows and flow breccias is the oldest unit exposed in the watershed. It outcrops in the Animas River Canyon near the mouths of Picayune, Burns, And Grouse Gulches, downstream from Animas Forks. The unit is altered greenish-gray, and weathers brownish-gray. The flows are commonly amygdaloidal (contain gas cavities or vesicles filled by secondary minerals).

Eureka Tuff Member A gray to greenish-gray welded ash-flow tuff of quartz latite to rhyolitic composition, with conspicuous eutaxitic structure (banded structure, resulting in a streaked or blotchy appearance). This tuff crops out in the lower part of California Gulch, the western side of Placer Gulch, and along the lower valley walls of the Animas River from Horseshoe Creek to Eureka. It outcrops over about one-third of the area of study.

Silverton Volcanics (Oligocene)

A sequence of predominantly intermediate composition lava flows and related volcaniclastic rocks were extruded onto the underlying Eureka Tuff in later Oligocene time. These volcanic flows have been subdivided into the following mapable formations exposed in the watershed, from oldest to youngest:

Burns Member A sequence of light to dark-gray, thin to thick, intertounging flows and domes of porphyritic dacite and rhyodacite overlies the Eureka Tuff, and crops out over about half the study area. These rocks have been propylitically altered throughout the watershed. (propylitic alteration described below). They are exposed in Burrows Gulch, across the saddle between Houghton and Tuttle Mountains, and in upper California Gulch. They also crop out in upper placer gulch, and form the upper slopes and peaks of California and Treasure Mountains, and much of lower Picayune Gulch.

Rhyolite Unit A prominently flow-laminated lava flow and associated tuffs found at the base of the overlying Andesite Member. This unit only occurs near the summits of Treasure Mountain and Cinnamon Mountain, and on the upper slopes of Eureka Mountain.

Andesite Member A pyroxene andesite combined with the Henson Member. This unit is a brownish weathering, dark-gray, porphyritic andesite in thick to thin, commonly amygdaloidal lava flows and flow-breccias. It also can contain gray, black, and brown lenticular interbedded sand and shaly tuffs, and locally, thin fresh-water limestones. This rock caps Tuttle Mountain, the northeast shoulder of Treasure Mountain, the headwall of Placer Gulch, and the summit of Cinnamon Mountain.

Younger Intrusive Rocks

Rhyolite (Miocene and Oligocene) Dikes, sills, plugs, and irregular shaped masses of white to light-gray, dense to moderately porphyritic rhyolite have intruded the older Burns Member and Eurka Tuff. The largest mass is intruded along a series of northeast trending faults at Denver Hill, and the northern foot of Houghton Mountain across from the London Mine. (An excellent example of an outcropping rhyolite dike can be observed at the confluence of Horseshoe Creek and the North Fork of the Animas River). A rhyolite mass also caps the western spur of the summit of California Mountain.

Quartz Latite Porphyry (Miocene and Oligocene Dikes, sheets, plugs, and irregular masses of light brown to gray, dense, aphanitic (crystal components invisible to the naked eye, ;glassy texture), to fine-grained rock with feldspar phenocrysts. This type of rock has intruded the older Eureka Tuff on the upper southeast shoulder of Houghton Mountain, the upper west-facing slope of Wood Mountain, and also as a thin, continuous dike which can be traced along the north valley wall of California Gulch from Houghton to Tuttle Mountain.

SURFICIAL GEOLOGY

The high alpine terrain in the watershed has been deeply scoured and sculpted by glaciers during the past 40,000 years. Exposed bedrock outcrop with thin patchy soils covers an estimated 80% of the surface. Unconsolidated surficial deposits are generally confined to the valley floors, and consist of remnant patches and aprons of glacial till, thin, patchy stream alluvium, and peat and organic bog deposits in wetland areas on the flat-floored glacially carved valleys. Talus and scree deposits mantle extensive areas of mountain slopes beneath cliffs and outcrops, where they have formed from continuous rock-fall. Debris fans composed of coarse, bouldery alluvium are commonly found at the mouths of steep ravines and tributary streams where they join the main valley.

Almost the entire watershed lies above timberline in a high alpine environment. Snow avalanches, debris flows in steep ravines and tributaries, and rock fall are constant geologic hazards which affect many parts of the area. Specific geologic hazards affecting sites of interest will be discussed in the individual mine site descriptions.

STRUCTURAL GEOLOGY

Structurally, the Upper Animas study area lies in the northern part of the Silverton Caldera. The watershed is affected by both the ring-fault structure defining the northern edge of the caldera, and the Eureka Graben, which defines a prominent down-dropped area within the caldera. Much of the upper headwaters area north of Animas Forks lies in a region of complex fault systems which strike northeast, tangential to the northern margin of the Silverton Caldera, continuing into the adjacent Lake City Caldera structure. The Eureka Graben and its associated northeast-striking faults are believed to have formed as the domed-up caldera rocks above active magma chambers relaxed and sagged back during periods of volcanic quiescence and magma retreat. During the various resurgences in volcanic activity through the late Tertiary, faults bounding the graben and tangential to the caldera were repeatedly reactivated. Today, the Eureka Graben is a boot-shaped structure bounded by a series of major, steeply dipping mineralized faults. (Burbank and Luedke, 1969)

Figure 2 is a map showing the structural geology of the area. The Upper Animas watershed is situated within and across the northern margin of the caldera. The Eureka Graben is outlined in heavy lines. As can be seen from the map, this part of the Silverton Caldera is complexly faulted and fractured. These repeatedly opened fractures were the locus for ore deposition, as ore forming fluids circulated through the subsurface much later in the geologic history of the caldera.

HYDROTHERMAL ALTERATION

All the volcanic rocks in the San Juan Volcanic Depression were extensively propylitized and altered on a regional scale, prior to ore deposition. "Propylitic" alteration is a term used to describe a particular type of mineralogic and chemical change that occurs by circulation of aqueous hydrothermal solutions through the original volcanic rock mass. The addition of carbon dioxide and water to the rock mass results in mineralogical changes to the rocks. Propylitic alteration in the caldera is typified by the formation and addition of chlorite, calcite, and clays in weakly altered rocks, to epidote, albite, and chlorite in the stronger phases. Propylitic alteration has resulted in a dull green or greenish gray color to virtually all of the volcanic flow rocks.

Solfataric alteration also occurs in the Upper Animas study area, but not nearly to the degree seen in Mineral Creek and parts of the Cement Creek watersheds. Rocks near the structural margin of the caldera on Houghton Mountain near the Columbus Mine, and along the Animas Fault at Eureka, have been highly altered by solfataric and hydrothermal processes. "Solfataric" processes have subjected the rock to attack and leaching by hot sulphurous gases and solutions moving upward along the structural margin of the Silverton Caldera. Hydrothermal processes have leached most of the base minerals from the rocks, while introducing such large amounts of sulfur that this type of altered terrain is readily distinguished from the surrounding regional propylitic alteration. Rock in these hydrothermal zones was so strongly altered and leached that little remains except silica, kaolinite, and sulfate and sulfide alteration products. Virtually all the potential buffering minerals in the country rock have been leached away, leaving a quartz-allunite-pyrite alteration assemblage more characteristic of the Red Mountain District. Bleaching of the rocks and subsequent surficial oxidation of the solfataric pyrite through geologic time has resulted in the brilliant red, orange, and yellow staining which characterizes the solfataric alteration zones, as seen in the cliffs around Eureka.

Wall rock adjacent to the mineralized veins has been subjected to more intense but localized alteration processes. Wall rock alteration occurred episodically as the veins were reopened and subjected to successive phases of mineralization from solutions having often very different composition. In the Burrows Gulch area, extensive silicification and deposition of quartz along the veins has resulted in spectacular, resistant, outcropping veins which can be traced by eye for thousands of feet across the surface.

BASELINE DATA COLLECTION

Water, mill tailings and waste rock were sampled and analyzed to better understand the sources of heavy metals in the Upper Animas River. The initial reconnaissance of the Upper Animas River was completed by the WQCD in 1991, 1992, and 1993. The WQCD collected water quality samples at 47 different locations, and analyzed the samples for various dissolved and total recoverable metals. The locations of these sites are shown on Figure 3 in smaller italicized underlined letters. The WQCD sampled the sites from 1 to 4 times during four sampling events. The number of dissolved and total recoverable analytes varied with each sample event.

Based on the WQCD results and further reconnaissance investigations, water quality sampling was conducted by the Division of Minerals & Geology (DMG) in September 1997 and July 1998. Mining waste sampling was conducted by the DMG in August, 1997. The locations of these sampling areas are shown on Figures 3 and 4.

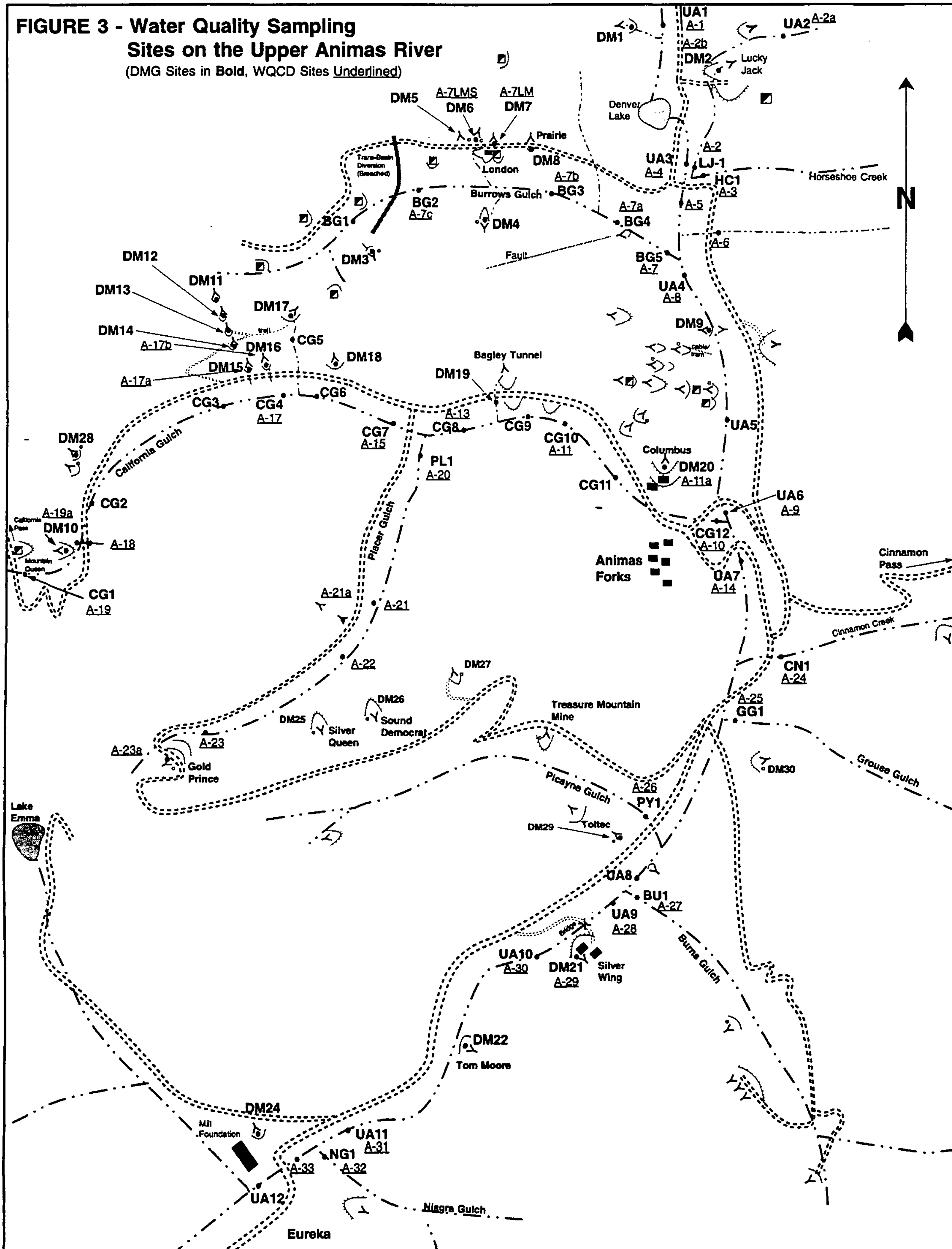
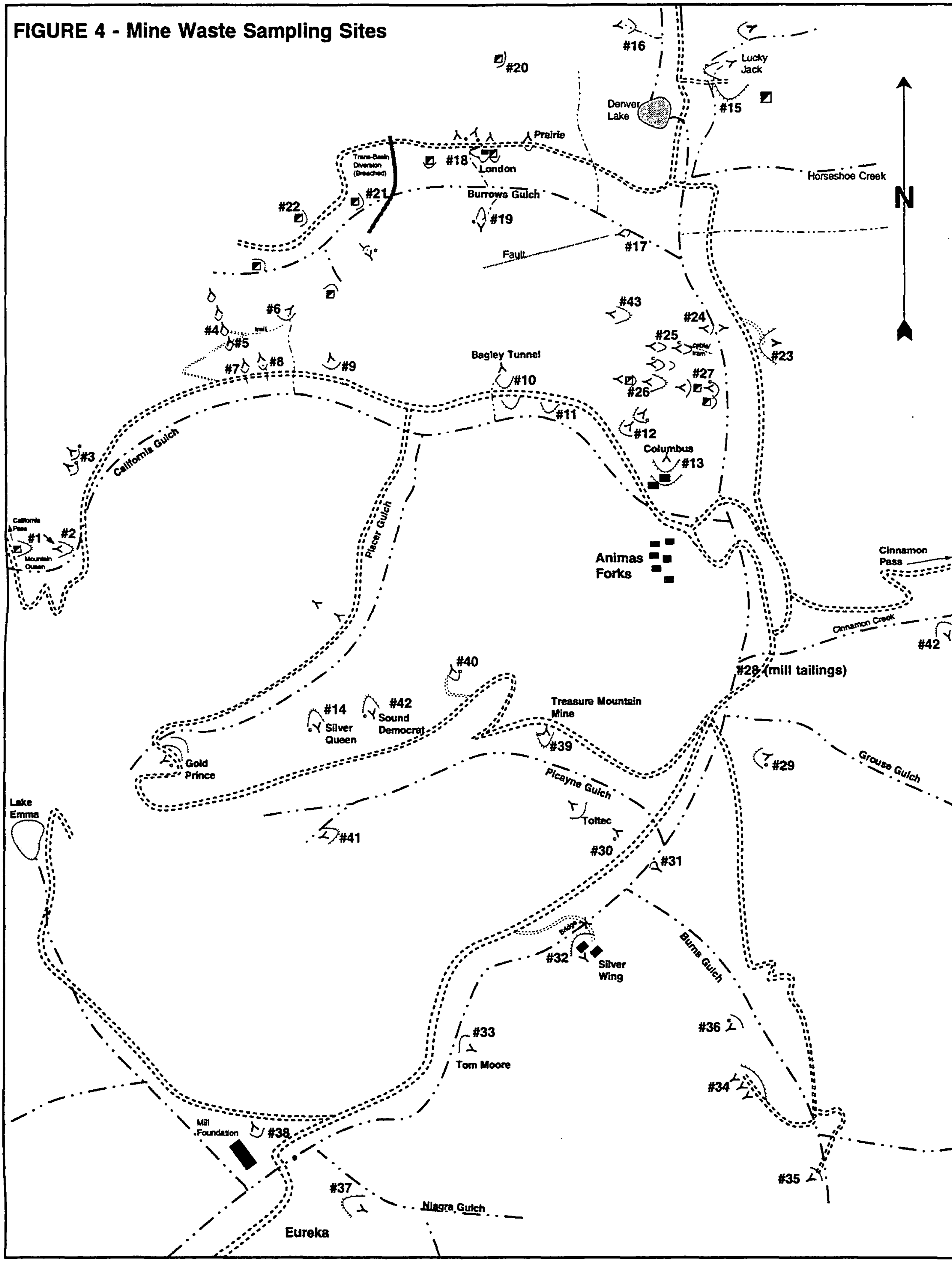


FIGURE 3 - Water Quality Sampling Sites on the Upper Animas River
(DMG Sites in **Bold**, WQCD Sites Underlined)

FIGURE 4 - Mine Waste Sampling Sites



WATER QUALITY SAMPLING

The DMG sampled along the Upper Animas River during the low-flow and high-flow regimes to determine the extremes in the amount of heavy metals contributed by various sources. Water samples were collected on September 3 and 4, 1997 to obtain the low-flow data and July 7 and 8, 1998 to obtain the high-flow data. During both sampling periods, the draining mine adits were sampled on the first day followed by sampling of the stream sites on the second day

Water samples were collected in the Upper Animas River above and below sites identified as potential sources during reconnaissance investigations. The DMG sampling plan included collecting dissolved metal, total recoverable metal, and major cation and anion samples at 66 different locations in the Upper Animas River. A list of the sampling sites, their locations and the time of year at which sampling was performed at that location is provided in Table 1. The locations of the sampling sites are shown on Figure 3 in large bold letters.

Water samples were collected by teams composed of volunteers and individuals from various government agencies. Raw depth and width integrated samples were taken in the stream. The total recoverable metals samples were then transferred directly to pre-cleaned pre-acidified 250 ml sample bottles; anion samples were transferred to pre-cleaned neutral 250 ml sample bottles; and dissolved metals samples were collected by filtering the raw water through a 0.45 micron filter into a pre-cleaned pre-acidified 250 ml sample bottle. After sampling, the samples were placed in coolers, and the anion samples were iced. All sampling activities were completed at the sampling site. During the sampling, pH, electrical conductivity and temperature were measured at the site.

During the September 1997 sampling event, flow measurements were taken at the same time that the water quality samples were collected. Water quality sampling and flow measurements were taken by continually moving up the watershed during the day. During the July 1997 sampling event, all of the water quality samples at stream sites were taken during the period between 2:40 p.m. and 4:50 p.m. on July 8, 1998. This was done to limit the diurnal flow variations in the streams. During the day, duplicate flow measurements and water quality samples were taken at three locations; stations UA-6, UA-12 and CG-12. The flow measurements at these sites plus duplicate measurements taken during the sampling period at other sites, were used to adjust the flow measurements taken earlier and later in the day.

The September 1997 low-flow data is presented in Appendix 1. The July 1998 high-flow data is presented in Appendix 2. It should be noted that the metals loading data in the appendices is reported in grams per day, whereas throughout the text, the data is reported in pounds per day. This was done to enable the reader to visualize the amounts better. To convert pounds to grams multiply the number of pounds by 454. Conversely, to convert grams to pounds, divide the number of grams by 454.

Table 1. DMG Sampling Program in 1997 and 1998

Sample No.	Location	Sept. 1997	July 1998	Comments
UA-1	Animas above Denver Lake	X	X	Headwaters
UA-2	Animas above Lucky Jack Mine	X	X	Headwaters
UA-3	Animas above Horseshoe Creek	X	X	
UA-4	Animas below Burrows Creek	X	X	
UA-5	Animas below mining complex	X	X	
UA-6	Animas above California Gulch	X	X	

Sample No.	Location	Sept. 1997	July 1998	Comments
UA-7	Animas below California Gulch	X	X	
UA-8	Animas above Burns Gulch	X		Velocity was too high to measure flow in 1998
UA-9	Animas below Burns Gulch	X		Velocity was too high to measure flow in 1998
UA-10	Animas below Silver Wing Mine	X		Velocity was too high to measure flow in 1998
UA-11	Animas above Niagara Gulch	X	X	
UA-12	Animas above Eureka Gulch	X	X	
CG-1	California Gulch above Mtn. Queen		X	Dry in September 1997
CG-2	California Gulch below Mtn. Queen	X	X	
CG-3	Cal Gulch above DM-11-16	X	X	
CG-4	Cal Gulch below DM-11-16	X	X	
CG-5	Tributary below DM-17	X	X	
CG-6	Cal Gulch below DM-17 tributary	X	X	
CG-7	Cal Gulch above Placer Gulch	X	X	
CG-8	Cal Gulch below Placer Gulch	X	X	
CG-9	Cal Gulch below Bagley Adit discharge	X	X	
CG-10	Cal Gulch below Bagley Mill Tailings	X	X	
CG-11	Cal Gulch above Columbus Mine	X	X	
CG-12	Cal Gulch above Animas Confluence	X	X	
BG-1	Burrows Creek above Trans-Basin Diversion	X	-	All flow diverted by diversion ditch July, 1998
BG-2	Burrows Creek above London Mine	X	X	
BG-3	Burrows Creek below London Mine	X	X	
BG-4	Burrows Creek above Large Fault	X	X	
BG-5	Burrows Creek above Animas	X	X	
LJ-1	Animas below Lucky Jack Mine	X	X	
HC-1	Horseshoe Creek	X	X	
PL-1	Placer Gulch	X	X	
CN-1	Cinnamon Creek	X	X	
GG-1	Grouse Gulch	X	X	
PY-1	Picayune Gulch	X	X	
BU-1	Burns Gulch	X	X	
NG-1	Niagara Gulch	X	X	
DM-1	Mine above Denver Lake	X	X	
DM-2	Lucky Jack Mine	X	X	
DM-3	Mine in Upper Burrows Creek	X	X	
DM-4	Mine South of London Mine	X	X	
DM-5	Mine near London Mine-West	X	X	
DM-6	Mine near London Mine-East	X	X	
DM-7	London Adit discharge	X	X	
DM-8	Prairie Adit discharge	X	X	
DM-9	Adit discharge below Burrows Creek	X		No flow in July, 1998
DM-10	Mountain Queen Adit Drainage	X	X	
DM-11	Upper adit Ida Mine		X	No flow in September, 1998
DM-12	Ida Mine			No flow in September 1997. Flow too low to measure in July, 1998
DM-13	Ida Mine		X	No flow in September, 1998
DM-14	Lower adit Ida Mine	X	X	
DM-15	Adit discharge in Cal Gulch-old A-17a	X	X	
DM-16	Adit discharge in Cal Gulch-old A-17b	X	X	
DM-17	Vermillion Mine	X	X	
DM-18	Vermillion Tunnel	X	X	
DM-19	Bagley Tunnel	X	X	

Sample No.	Location	Sept. 1997	July 1998	Comments
DM-20	Columbus Mine	X	X	
DM-21	Silver Wing Mine	X	X	
DM-22	Tom Moore Mine	X	X	
DM-24	Mine near Eureka Mill	X	X	
DM-23	Mine south of Eureka			No flow. There was evidence of past flow
DM-25	Silver Queen Mine	X	X	
DM-26	Sound Democrat Mine	X	X	
DM-27	Mine in Upper Picayune Gulch	X	X	
DM-28	Mine in Upper California Gulch	X	X	
DM-29	Toltec Mine	X	X	
DM-30	Mine between Grouse and Burns Gulch	X	X	
DM-31	Mine in Lower Burrows Creek	X		No flow in July, 1998

MINING WASTE SAMPLING

Mining waste samples were collected at 43 different locations in the Upper Animas River. The samples included 41 waste rock sites and 2 mill tailings sites. Vegetated soils in Picayune Gulch and Burrows Creek and unvegetated talus in Burns Gulch were also sampled. The location of the sampling sites is shown on Figure 4. The mining wastes were investigated to provide information sufficient to allow the Animas River Stakeholders Group to prioritized mine sites for reclamation.

A 2:1, by volume, extract was collected in the field. The extract was analyzed for field parameters, then a portion was analyzed in the laboratory for heavy metals and major cations.

Waste rock and soil/outcropping samples were collected from a minimum of ten and maximum of twenty locations at each site. Acid-washed plastic 100 ml beakers were used to remove the top two inches of material. The 10+ sub-samples from each site were composited in a 1-gallon re-closeable plastic bag. The composited samples were thoroughly mixed in the field by inverting the bag numerous times. After mixing, 150 ml of sample was removed and placed in a 1 liter plastic beaker along with 300 ml of deionized water. The wetted sample was then vigorously mixed for 15 seconds, plastic wrap was placed over the top, then left to settle for 90 minutes. Ninety minutes was the amount of time it took for the clay fraction to settle to the bottom of the beaker.

After 90 minutes, the liquid was filtered through very fine grade soil filters (approximately 2 micron). A portion of the liquid was then used to measure the total acidity, pH, and specific conductance. The remaining liquid was acidified with nitric acid for lab analysis. Total acidity was determined using a Hach digital titrator to reach a phenolthalein end-point. Specific conductance and pH were measured with a HyDAC instrument.

The data from the waste rock sampling is presented in Appendix 3. Results for total acidity, aluminum, copper, and zinc is also reported on Figures 5 and 6.

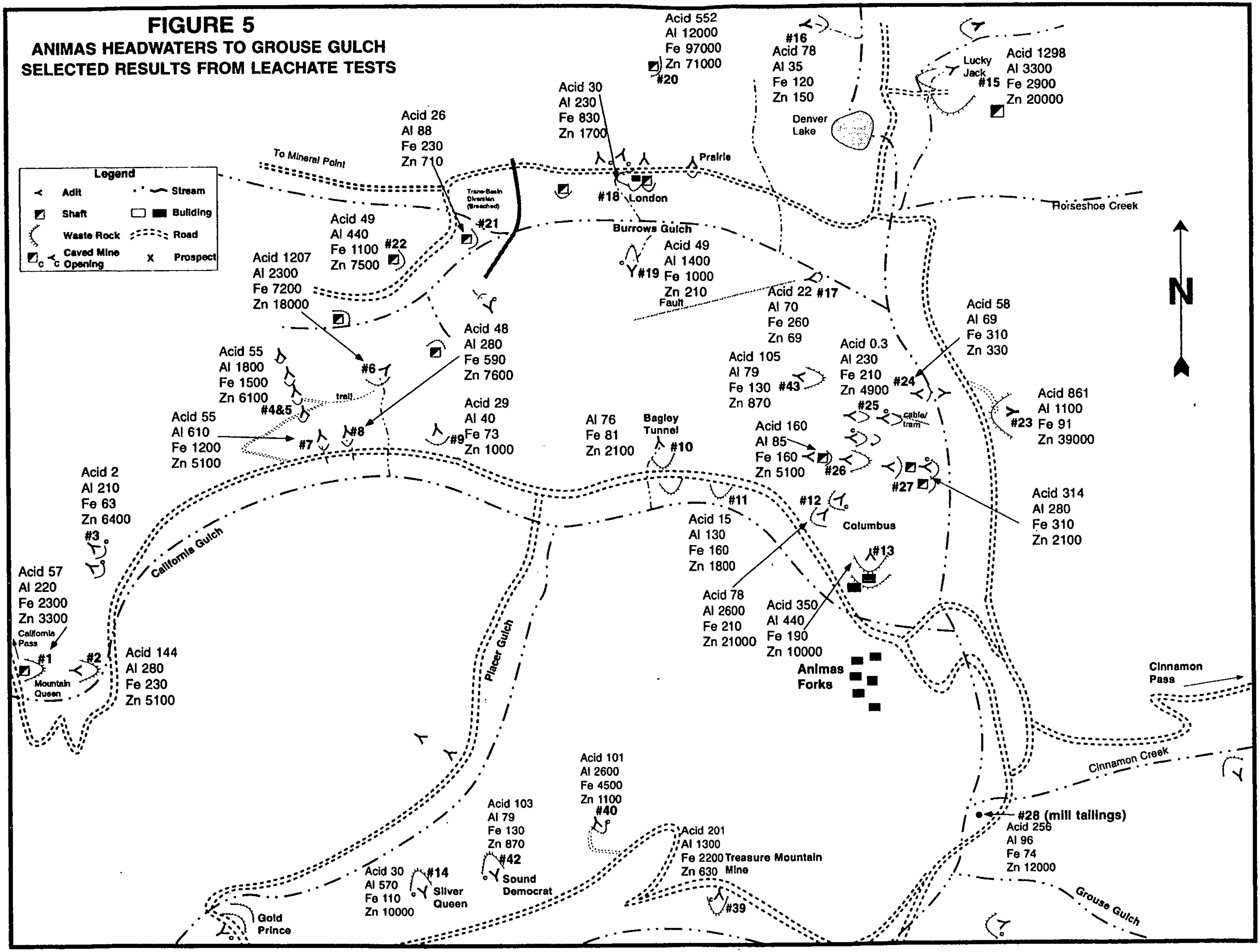
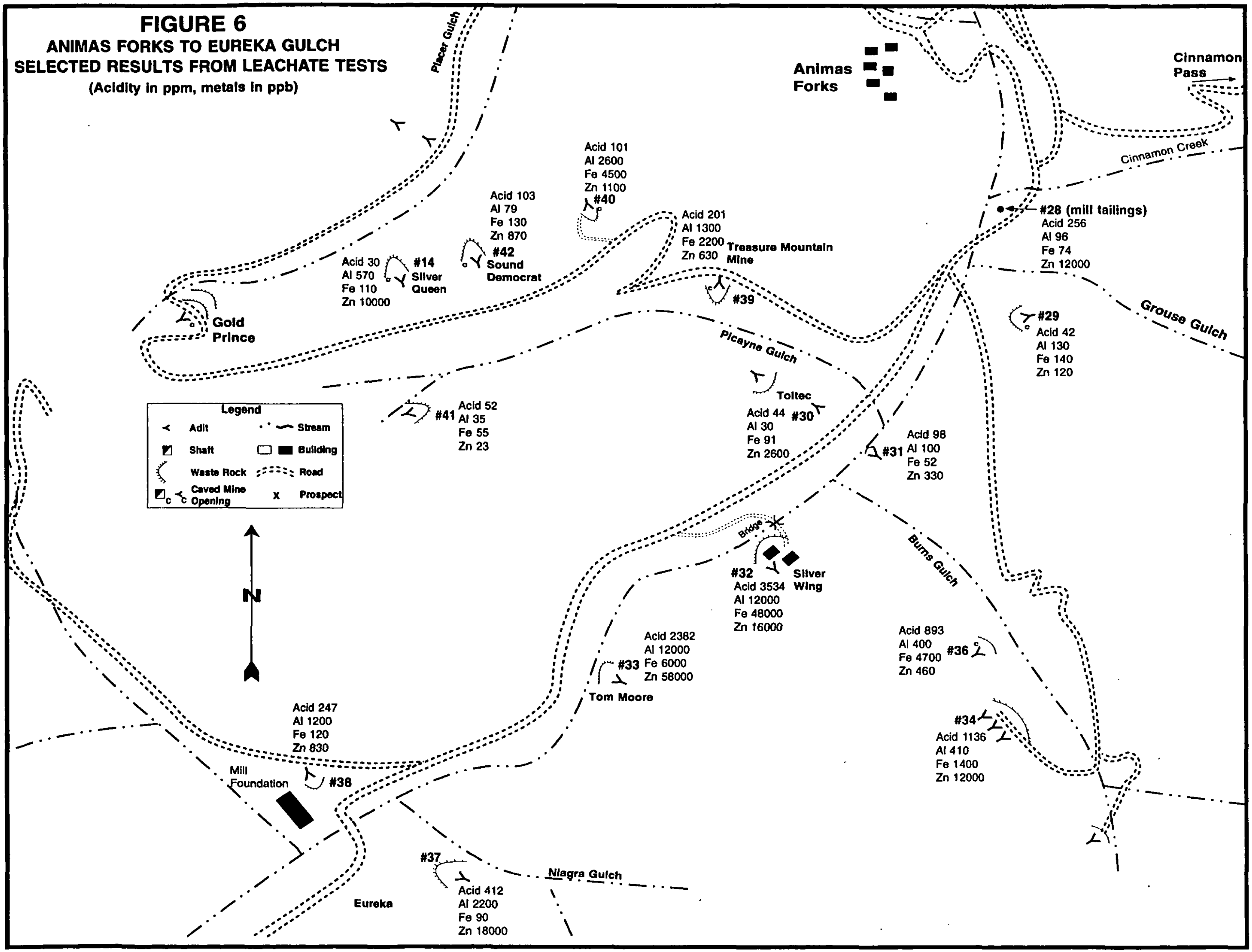


FIGURE 5
ANIMAS HEADWATERS TO GROUSE GULCH
SELECTED RESULTS FROM LEACHATE TESTS

FIGURE 6
ANIMAS FORKS TO EUREKA GULCH
SELECTED RESULTS FROM LEACHATE TESTS
(Acidity in ppm, metals in ppb)



Natural background samples were taken at three sites. In general, the natural background samples were an order in magnitude lower in acidity and metals than the mining waste samples. The average acidity of the mining waste samples was 319 compared to an average of 47 for the background samples. The background acidity is comparable to that found in Cement Creek for non-solfatarically altered materials. The average total metal content of the mining wastes was approximately 23,000 parts per billion (ppb), compared to approximately 1,250 ppb for the background materials. This data indicates that, in general, the mining wastes produce one order of magnitude more metals than the natural soils and outcroppings.

WATERSHED CHEMISTRY

The water chemistry in the Animas River above Eureka is very complex, because there are both natural and mining-related metals loading affecting the streams. There are also some differences in speciation of metals due to the varying geology of the area.

Water samples were tested for the concentration of many different metal types, but zinc, iron and copper are thought to be the principal metals impacting aquatic life in the Animas River. Based upon the water quality data collected by DMG and CDPH&E, the major metals of importance in the Animas River above Eureka are aluminum, iron, and zinc.

Iron plays a minor role in the water chemistry of the Upper Animas River. Iron may, however, play a significant role in removal of zinc. The lack of iron in most of the drainages means that there is very little zinc sorbed to precipitated iron. The majority of the iron in the Animas River comes from Burrows Creek and California Gulch. The maximum iron concentration was found *in the headwaters above Denver Lake. The highest concentration in the mainstem of the Upper* Animas River was 18 and 56 ug/l at high-flow and low-flow, respectively.

Copper concentrations are generally low throughout the mainstem of the Upper Animas River. The highest dissolved copper concentration measured in the mainstem during low-flow was 20 ug/l below Burrows Creek. The highest dissolved copper concentration found in the mainstem during high-flow was 5 ug/l below Burrows Creek, and again above the confluence with Eureka Gulch. Copper concentrations are generally above aquatic limits in Burrows Creek, California Gulch and Placer Gulch. The largest in-stream copper loading occurs below Burns Gulch, while the highest in-stream copper concentration was found in Burrows Creek. The principal source of copper throughout the basin appears to be from groundwater inflow sources. In Burrows Creek, the adit discharges can account for a maximum of 2.2% of the copper load during low-flow, and 13.6% during high-flow. In California Gulch above the confluence with Placer Gulch, the adit discharges can account for a maximum of 23.2% of the copper during high-flow. During low-flow, the copper at station CG-7 was below detection limits.

The white precipitate observed on the streambed of California Gulch and the Animas River below Burrows Creek is believed to be principally aluminum, but also partially zinc. Aluminum and zinc will be discussed separately below.

UPPER ANIMAS IN-STREAM ALUMINUM

Aluminum precipitate first appears in the Upper Animas below the Lucky Jack Mine. The headwaters at UA-1 and UA-2 have aluminum concentrations below detection limits (Figure 7 & 8). Adit discharge DM-1, above Denver Lake, produces aluminum, but there is no visible precipitate in the stream below the mine drainage confluence. Most of the aluminum from DM-1 probably precipitates before reaching the receiving stream. Below Denver Lake, at station UA-3, aluminum is still below detection limits. The Lucky Jack adit discharge, combined with leaching of the waste rock, increases the aluminum concentrations in the stream. During low-flow, all of the aluminum from the Lucky Jack Mine precipitates in the stream channel, and concentrations are again below detection limits at station LJ-1. At high-flow, most of the aluminum input from the Lucky Jack Mine precipitates, but concentrations are above detection limits at station LJ-1.

Below the confluence of Burrows Creek with the Upper Animas River, white aluminum precipitate becomes visible. The majority of the aluminum in Burrows Creek comes in between sampling sites BG-2 and BG-3. During low-flow, the load increases from 4.4 pounds per day to 27.1 pounds per day between these stations (Figure 9). During high-flow, the load increases from 27.8 to 57.1 pounds per day between these stations (Figure 10). The adit discharges in this area can only account for 1% and 3.3% during low-flow and high-flow, respectively. In fact, all the adit discharges in Burrows Creek can only account for 1.3% and 1.8% of the aluminum load at station BG-5 during low-flow and high-flow, respectively. Very little of the aluminum load in Burrows Creek can be attributed to leaching from waste rock piles. Most of the waste rock piles are located away from the stream, where any aluminum in the leachate would precipitate. Therefore, virtually all the aluminum load must come from groundwater inflow sources.

Between Burrows Creek and California Gulch, the aluminum concentrations generally decrease. At station UA-6, aluminum concentrations were below detection limits during both the low-flow and high-flow sampling. There was a slight increase in aluminum concentration below the Columbus Group waste piles during low-flow, possibly from waste rock leaching.

California Gulch is the principal source of aluminum in the Upper Animas River during high-flow. During low-flow, Burrows Creek produces more aluminum at its confluence with the Upper Animas River, but the largest loading measured was in California Gulch at sampling site CG-3. Loads measured at the mouth of California Gulch were approximately 87 and 5 pounds per day during high-flow and low-flow, respectively.

The headwaters of California Gulch exhibit aluminum precipitate on the substrate above the Mountain Queen Mine, but concentrations and loading are minimal through sampling site CG-2. At sampling site CG-3, concentration and load increase dramatically. The source of the aluminum appears to be groundwater inflows along faults and fractures from California Mountain. The only adit discharge in this segment (DM-28), has aluminum concentrations below detection limits.

Between sampling sites CG-3 and CG-4, aluminum load and concentration increased slightly during high-flow and decreased slightly during low-flow. The adit discharges (DM-11-16) could be partially responsible for the increase in load, but the concentrations are lower in the adit discharges than in the stream, indicating some groundwater inflow input in this segment. Because of the distance between the adit discharges in this segment, and the stream, it is likely that most of the aluminum precipitates before reaching the stream.

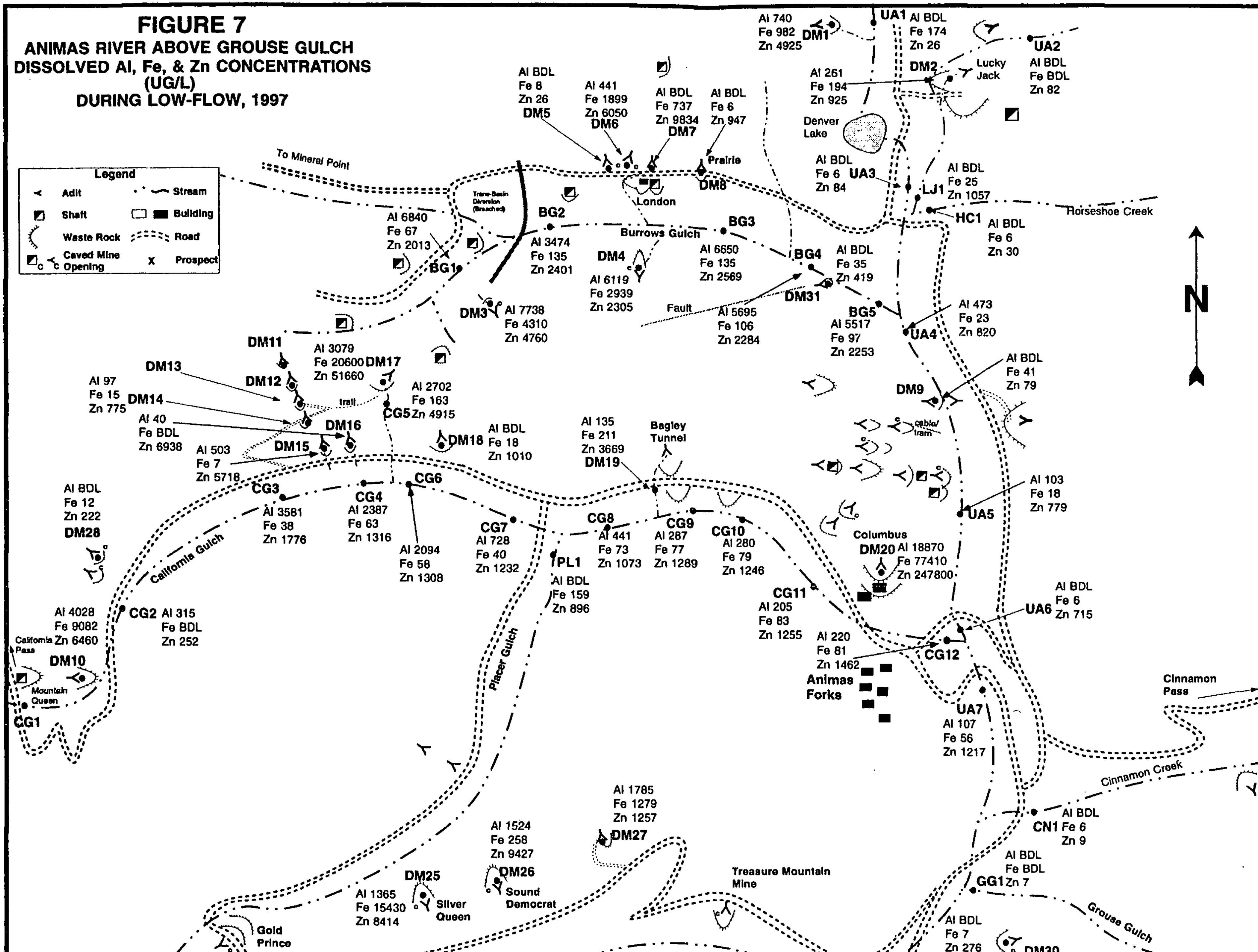


FIGURE 7
ANIMAS RIVER ABOVE GROUSE GULCH
DISSOLVED Al, Fe, & Zn CONCENTRATIONS (UG/L)
DURING LOW-FLOW, 1997

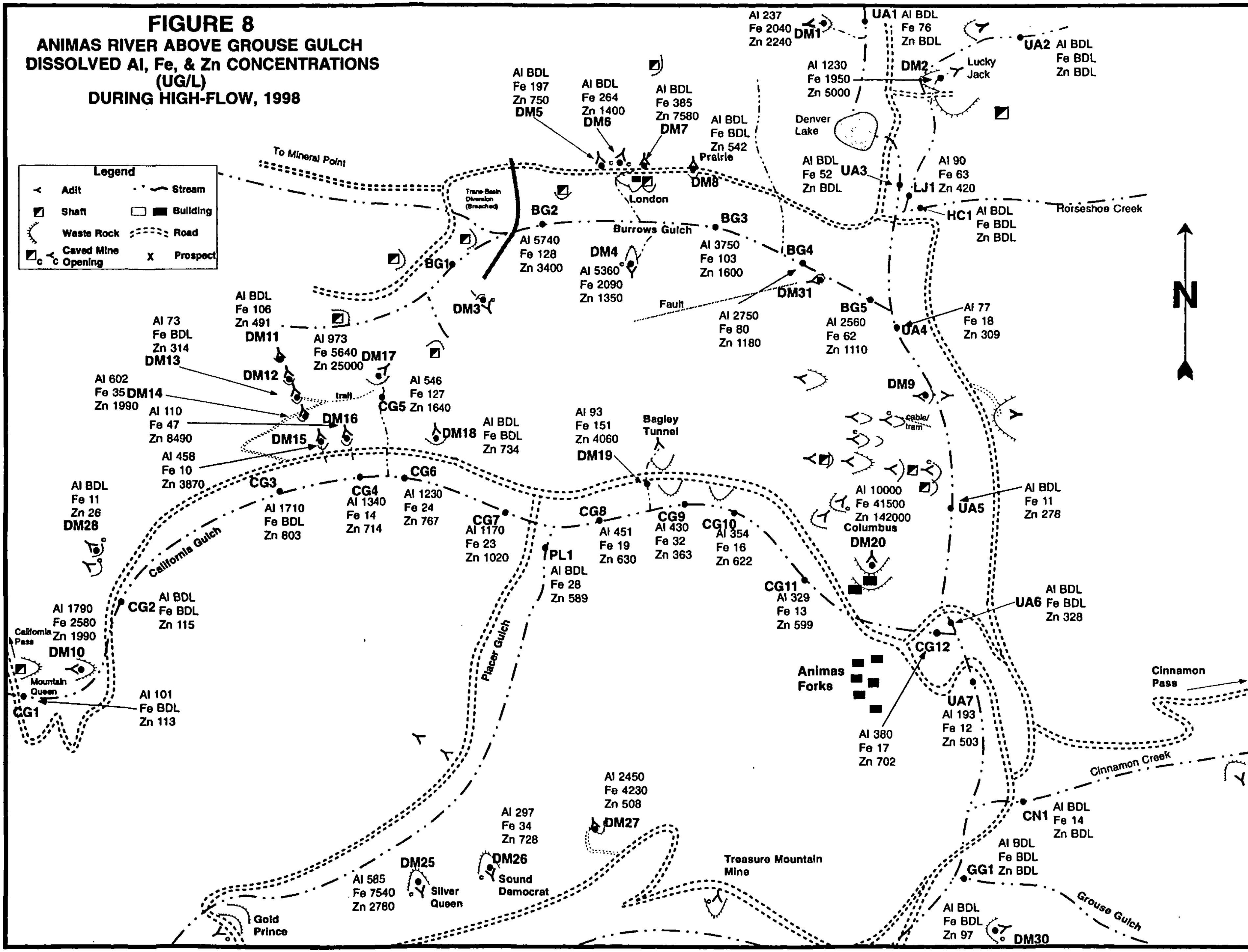


FIGURE 8
ANIMAS RIVER ABOVE GROUSE GULCH
DISSOLVED Al, Fe, & Zn CONCENTRATIONS
(UG/L)
DURING HIGH-FLOW, 1998

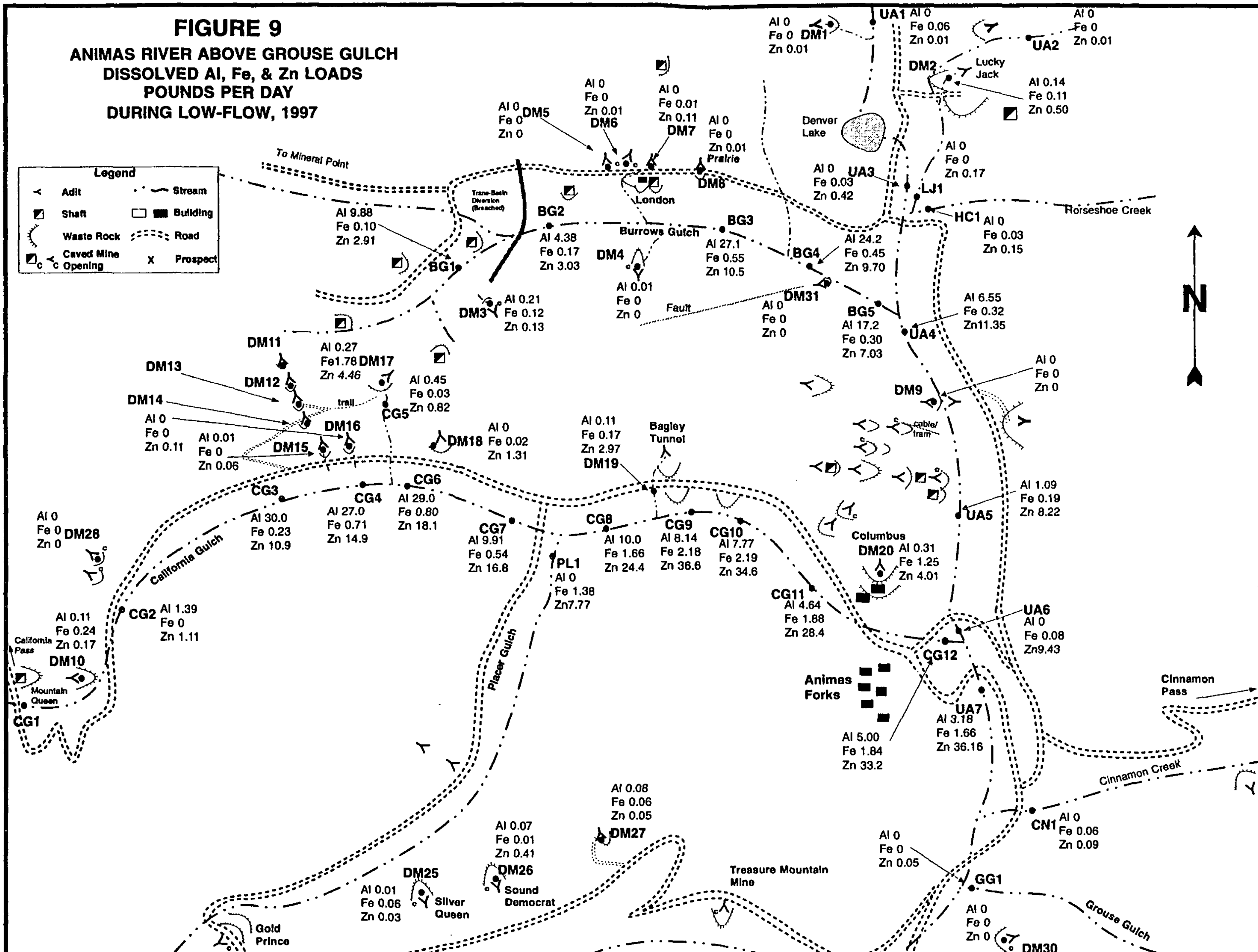
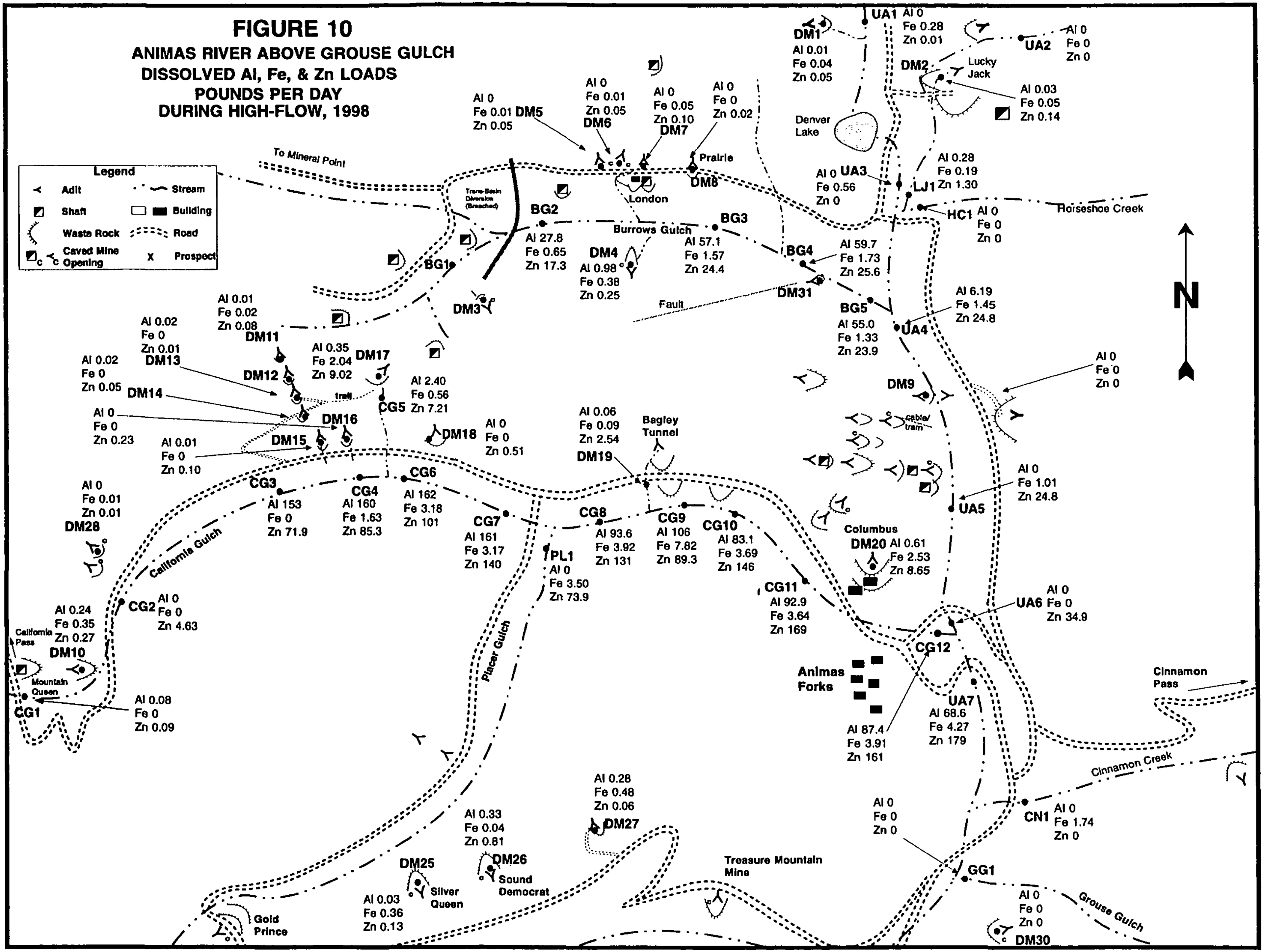


FIGURE 9
ANIMAS RIVER ABOVE GROUSE GULCH
DISSOLVED Al, Fe, & Zn LOADS
POUNDS PER DAY
DURING LOW-FLOW, 1997

FIGURE 10
ANIMAS RIVER ABOVE GROUSE GULCH
DISSOLVED Al, Fe, & Zn LOADS
POUNDS PER DAY
DURING HIGH-FLOW, 1998



Between sampling sites CG-4 and CG-6, the aluminum loads increased slightly during both low-flow and high-flow (Figures 9 & 10). The adit discharge from DM-17 and subsequent leaching of the waste rock appears to be principally responsible for this increase. Between sampling sites CG-6 and CG-7, there was very little change in loading during high-flow, but a large drop occurred during low-flow. The white precipitate becomes very evident below sampling site CG-6. The adit discharges above sampling site CG-7 can account for a maximum of 3.9% and 0.4% of the aluminum load at CG-7 during low-flow and high-flow respectively.

Below CG-7 is the confluence with Placer Gulch. Aluminum concentrations from Placer Gulch were below detection limits during the low-flow and high-flow samplings (Figures 7 & 8). Below Placer Gulch, aluminum load generally declines downstream. There was a slight increase during high-flow below the Bagley Tunnel (DM-19).

Below the confluence of California Gulch and the Upper Animas River, aluminum concentrations and load rapidly decline as relatively clean tributaries join the flow (Figures 11, 12, 13, & 14). Once the stream reaches Burns Gulch, the aluminum load and concentration from there to Eureka is insignificant. At sampling site UA-7, the maximum amount of the aluminum load that can be accounted for by the adit discharges is 38.7% at low-flow and 4% at high-flow. As most of the aluminum from the adits has precipitated before it reaches station UA-7, both estimates are high. It is estimated that adit discharges account for less than 2% of the aluminum at station UA-7 during low-flow and high-flow.

UPPER ANIMAS IN-STREAM ZINC

Aluminum in the Upper Animas River is problematic because of the white precipitate that colors the streambeds and interferes with the substrate, whereas zinc appears to be the principal metal toxic to aquatic life. Zinc concentrations in the headwaters of the Upper Animas River at sampling sites UA-1 and UA-2 are generally below detection limits during high-flow, but are 26 and 82 micrograms/liter (ug/l), respectively at low-flow (Figures 7 & 8). Although adit discharge DM-1 has a high concentration of zinc, it appears to have only a minor effect on water quality. During high-flow, the zinc concentrations at station UA-3 below it are below detection limits. During low-flow, there is a rise in zinc concentration between UA-1 and UA-3 from 26 to 84 ug/l. There is a population of brook trout that inhabits Denver Lake and the stream between Denver Lake and UA-1.

Between stations UA-2 and LJ-1, the zinc concentration increases sharply due to adit discharge and leaching of the waste rock from the Lucky Jack Mine (DM-2). Below the confluence of UA-3, LJ-1 and Horseshoe Creek (HC-1), zinc concentrations again drop, then rise again below the confluence with Burrows Creek.

Zinc concentrations are high in the headwaters of Burrows Creek. The stream follows a mineralized fracture system for most of its reach from the headwaters to the trans-basin diversion. The trans-basin diversion was breached at the time of the low-flow sampling, but was repaired and functioning at the time of the high-flow sampling. Zinc concentrations were actually higher during high-flow at station BG-2 than at low-flow.

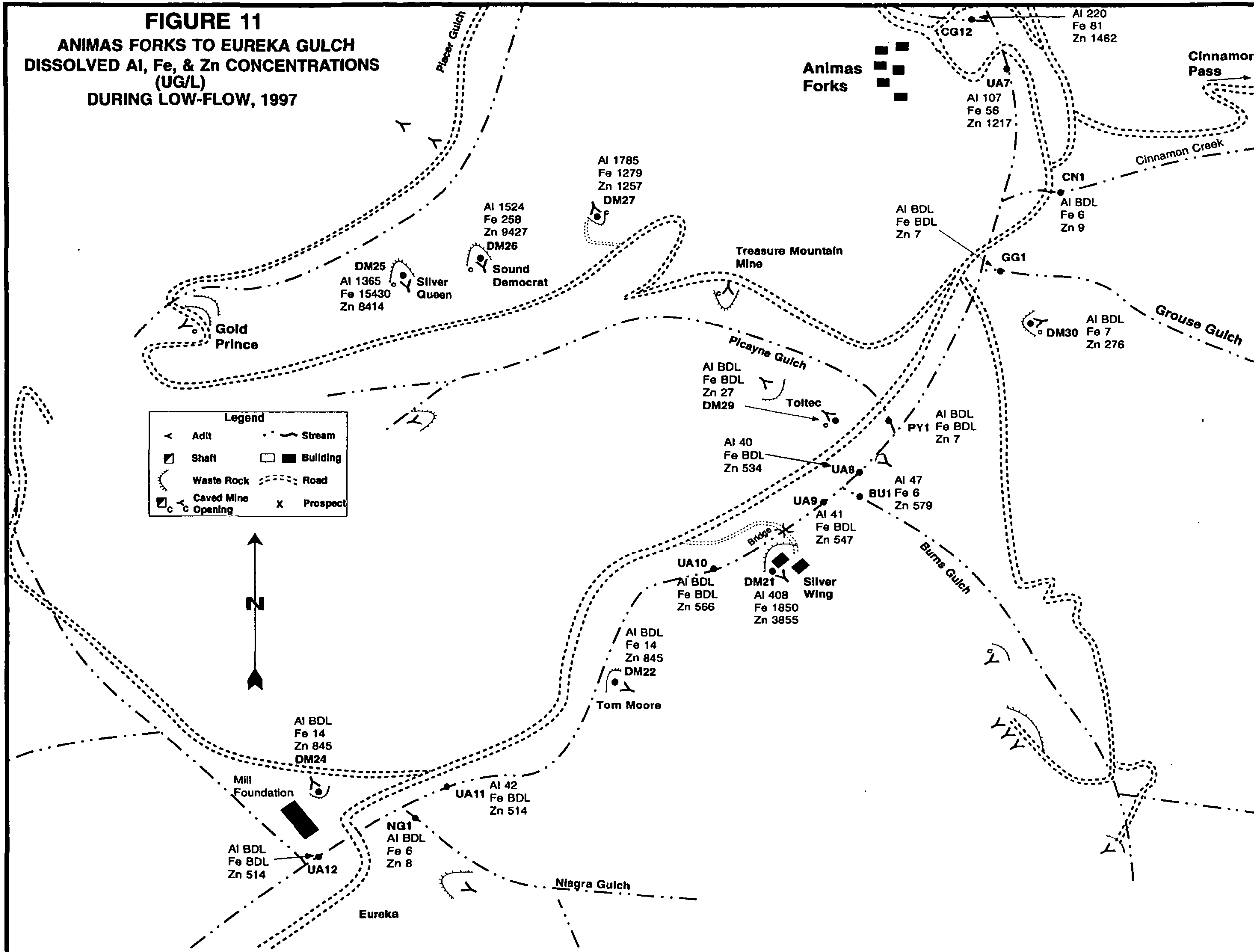
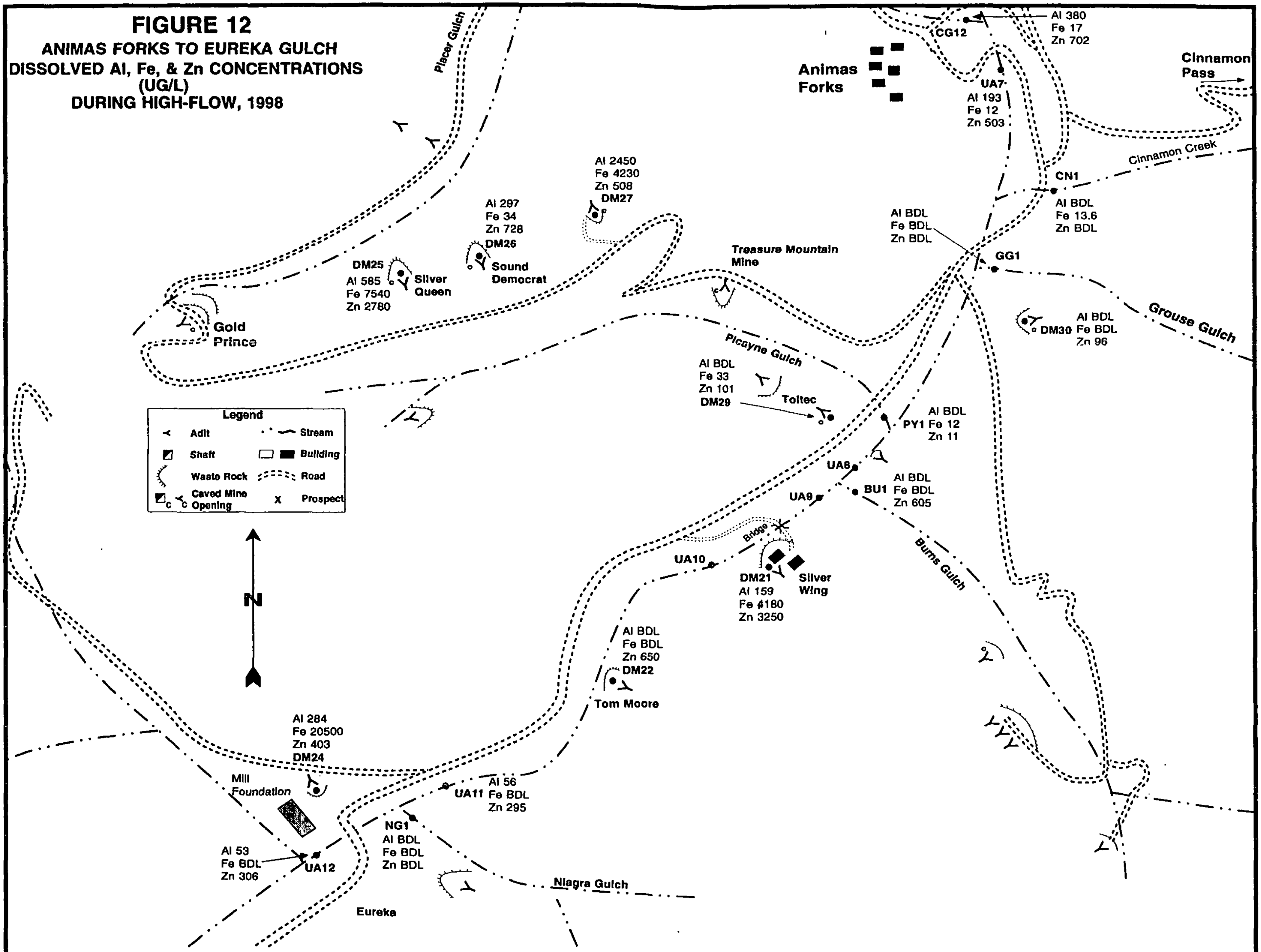


FIGURE 11
ANIMAS FORKS TO EUREKA GULCH
DISSOLVED Al, Fe, & Zn CONCENTRATIONS (UG/L)
DURING LOW-FLOW, 1997

FIGURE 12
ANIMAS FORKS TO EUREKA GULCH DISSOLVED Al, Fe, & Zn CONCENTRATIONS (UG/L) DURING HIGH-FLOW, 1998



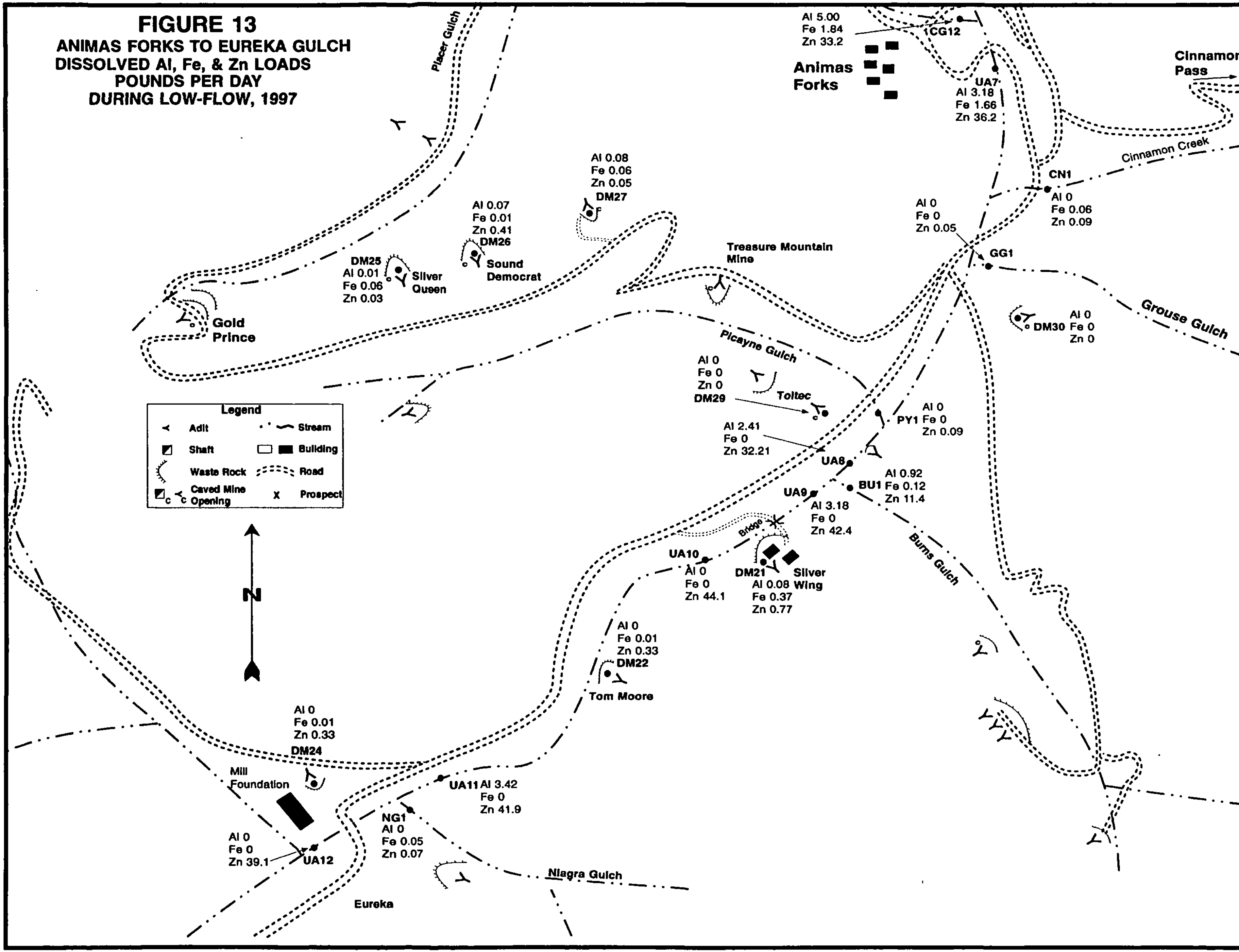
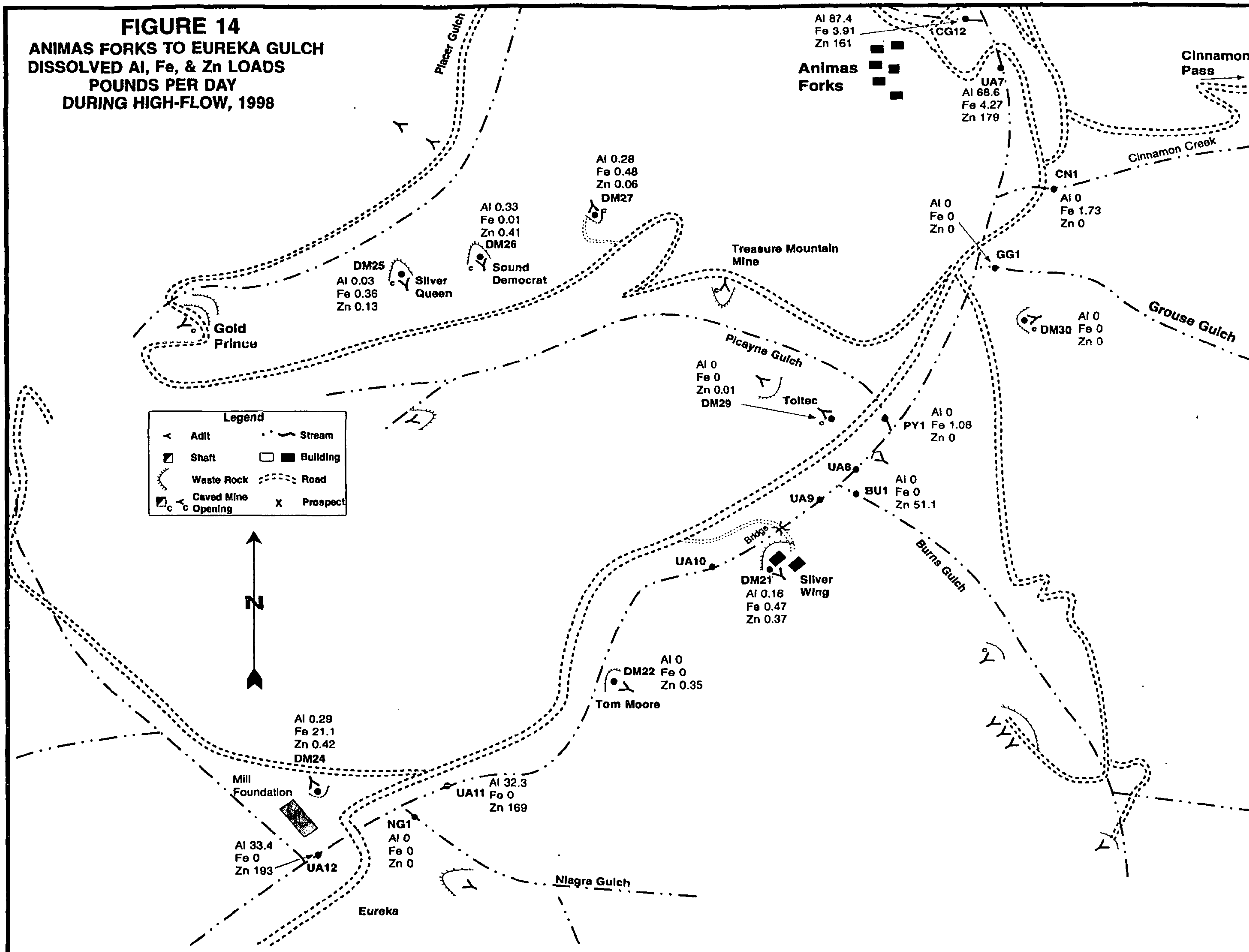


FIGURE 13
ANIMAS FORKS TO EUREKA GULCH
DISSOLVED Al, Fe, & Zn LOADS
POUNDS PER DAY
DURING LOW-FLOW, 1997

FIGURE 14
ANIMAS FORKS TO EUREKA GULCH DISSOLVED Al, Fe, & Zn LOADS POUNDS PER DAY DURING HIGH-FLOW, 1998



This indicates that there is considerable zinc input to this segment along the flanks of Houghton Mountain. Between stations BG-2 and BG-3, the zinc loads increased dramatically during high-flow and slightly during low-flow (Figures 9 & 10). The adit discharges in this segment (DM-4 to 8) can account for a maximum of 3.3% of the load increase during low-flow and 6.6% during high-flow. This further suggests that most of the zinc in Burrows Creek comes from groundwater inflow sources. Below station BG-3, zinc concentrations and loads generally decrease to the confluence with the Upper Animas River (Figures 11 & 12). During low-flow, the zinc load remained nearly constant to the mouth of Burrows Creek.

Between stations UA-4 and UA-6, zinc concentrations generally decline during both low-flow and high-flow. During low-flow, the zinc load also declines, but increases during high-flow. The majority of the increase in this segment cannot be attributed to surface inputs. At station UA-4, less than 2.6% of the zinc can be accounted for by waste piles and adit discharges in the upper watershed.

In the headwaters of California Gulch, zinc concentration and load are generally low until station CG-3, where load and concentration increases dramatically during low-flow and high-flow. Virtually all the zinc increase appears to be from groundwater inflow sources, since the zinc load from the only adit discharge between stations CG-2 and CG-3 is insignificant. During low-flow and high-flow, zinc loads generally increase downstream of CG-3 to the confluence with the Upper Animas River. With a few exceptions, zinc concentrations generally remain the same or fall downstream of station CG-3. At Station CG-7, upstream from Placer Gulch, the adit discharges can account for a maximum of 36.6% of the zinc at low-flow and 7.3% at high-flow. At station CG-12, the adit discharges can account for a maximum of 40.8% and 13.9% of the zinc at low-flow and high-flow, respectively. Between stations CG-8 and CG-12, the adit discharge from the Bagley Tunnel and Columbus mines can account for up to 79.6% and 36.4% of the zinc at low-flow and high-flow respectively.

At station UA-7 below the confluence of the Upper Animas River and California Gulch, the adit discharges can account for a maximum of 39.6% of the zinc at low-flow and 14.3% of the zinc at high-flow. Below UA-7, zinc concentrations and load decline until the confluence with Burns Gulch (Figures 11, 12, 13, and 14). The zinc loading from Burns Gulch is approximately 51 pound per day during high-flow and 11 pounds per day during low-flow. The zinc load increased slightly below the Silver Wing Mine during low-flow. Below the Silver Wing Mine, zinc load decreases to the last downstream station in this study, above Eureka Gulch.

RECLAMATION OPTIONS

There are many different types of mining related disturbances in the Upper Animas watershed that affect water quality. A thorough understanding of the hydrologic system is necessary to determine which reclamation options would be best at a particular site. Reclamation of the watershed will be complicated and several reclamation options may be required at some sites to provide the most cost-effective cleanup.

One of the most complex alternatives involves the reclamation of adit discharges. These situations may involve collection and treatment of the mine drainage. In many cases, there is more water leaving the mine site than is measured at the mine adit. Some of the water flows underground through fracture systems into the stream. A groundwater-minepool interaction commonly exists because of the complex geology and extensive mining that has occurred. If a treatment system is contemplated to address the mine discharge, it will be necessary not only to understand the chemistry and hydrology of the adit discharge, but also to determine any potential groundwater loadings that leave the site through fractures or other geologic structures. The fractured, jointed, highly altered nature of the bedrock could be allowing seepage from the mine workings to enter the groundwater system. A treatment system could work well on the adit discharge, but fail to meet metals removal goals in the stream due to unidentified groundwater pathways to the stream. In that case, simply sticking pipes into the adits would not be adequate to collect all the water that needs to be treated. It may be necessary to re-enter the adit to the point where contaminated flows can be collected and intercepted before they are lost to the groundwater system.

Reclamation and treatment methods considered in this feasibility investigation include:

1) Surface Hydrologic Controls (Preventative Measures); diversion ditches, mine waste removal and consolidation, stream diversion, revegetation

2) Passive Treatment anoxic limestone drains, settling ponds, sulfate reducing wetlands, aqueous lime injection, limestone water jet, oxidation wetlands, aeration, powered mechanical neutralization systems, dilution, electro-kinetics, and land application.

3) Subsurface Hydrologic Controls (Preventive Measures); in-mine diversions of clean flows, pre-treatment of ore bodies or mined out areas, preventing subsurface flows from entering mine workings through mine openings, faults, and other geologic structures.

A short description of each method is given below.

SURFACE HYDROLOGIC CONTROLS

Most hydrologic controls are preventative measures in that they inhibit or prevent the process of acid formation and/or heavy metal dissolution. If it is possible to prevent water from entering a mine, or coming into contact with sulfide ores or wastes, this can be the best, most cost effective reclamation approach.

Diversion ditches are effective where run-on water is degraded by flowing over or through mine waste, or into mine workings. Diversion ditches can also be used to intercept shallow ground water that may enter mine waste. In some cases, mine discharge can be improved by flowing through the waste rock. Mine drainage must be sampled above and below a waste rock pile to determine whether the waste rock is actually degrading the water quality.

Mine waste removal and consolidation is effective where there are several small mining waste piles in an area, or where there is a large pile in direct contact with flowing water. The method is simply to move reactive material away from water sources.

Stream sealing or diversion involves moving the water sources away from reactive materials, or sealing/ lining streams to prevent surface inflows into shallow mine workings through stopes, shafts, or fracture systems. It may include lining or grouting/ sealing the stream bed or bedrock.

Revegetation is often used in combination with other hydrologic controls above. Revegetation by itself can be a very effective method of reducing heavy metals concentrations, particularly where much of the metals come from erosion of mining waste into a stream. Revegetation also reduces the amount of water that infiltrates a waste pile, thereby reducing leachate production. The roots of growing plants also have been shown to produce carbonates through respiration.

PASSIVE TREATMENT

Anoxic limestone drains are the simplest method of introducing alkalinity into mine discharges. Anoxic limestone drains (ALD) are constructed by placing coarse limestone (3/4" - 3") inside an adit or in a fully sealed trench outside a discharging mine. In order for an ALD to function properly, the mine discharge must be devoid of oxygen. In the absence of oxygen, limestone will not become coated by iron and other metal hydroxides, which can shorten the useful life of limestone. In addition, the mine drainage should be relatively low in dissolved aluminum. Aluminum has been shown to precipitate in ALDs, causing plugging. It is theorized that very coarse limestone (4-6") should provide large enough pore spaces to minimize or prevent clogging by aluminum. The disadvantage of using larger limestone is the reduced surface area to react with the mine drainage. After the mine drainage exits the ALD, aeration causes precipitation of metals. The increase in pH due to ALDs is site specific, but generally does not exceed two standard units.

Settling ponds are often overlooked as an effective treatment method. Settling ponds are particularly effective for treating near neutral mine drainages high in total suspended solids (TSS). Aeration of a near neutral pH mine drainage by means of a series of drops, followed by a settling pond can effectively remove iron and other metals that co-precipitate with the iron. Settling ponds should be designed for a 24-hour or greater retention time wherever possible.

Sulfate reducing wetlands are often called bioreactors. These systems treat water through bacterial reduction of heavy metals. Sulfate reducing bacteria (SRBs) utilize the oxygen in sulfates for respiration, producing sulfides. The sulfides then combine with heavy metals to form relatively insoluble metal sulfides. The bacteria derive their energy from a carbon source such as cow manure or mushroom compost. There are many other substrates that are an acceptable source of carbon, but most have a low hydraulic conductivity that can result in short circuiting of the system by the formation of preferential flow paths. Sulfate reducing bacteria cannot survive in a drainage with pH below 4.5. Highly acidic drainages will require a pH increase before the effluent enters the bioreactor.

Sulfate reducing wetlands should generally not be constructed near population centers. These systems commonly produce excess hydrogen sulfide, which can cause undesirable odors up to 3 mile from the system. When initially started, organics in the substrate discolor the treated water for several months, making water quality appear, to the layman, to be worse than that entering the system.

Aqueous lime injection is a passive method to introduce neutralizing agents into mine drainage. This system requires a clean water source. Clean water is passed through a pond containing neutralizing agent, then the high pH effluent is mixed with the mine drainage before it enters a settling pond. This system can be cost effective if alkaline wastes such as kiln dusts or fly ash are available. Although still in the experimental phase, the method holds promise for some mine sites. Neutralizing materials may also be injected into stopes and drifts, to prevent ARD.

Limestone water jets are an aerobic method of accelerating the dissolving of limestone. In situations where mine drainage flows down a steep slope, the discharge can be piped, and the resultant head can produce a high pressure water jet. The high pressure jet can be either sprayed onto loose crushed limestone, or passed upward through a vessel containing limestone. In both situations, the limestone does not become coated because of abrasion by the water jet, and agitation of the surrounding clasts. The system using a vessel can result in higher alkalinity in the effluent due to greater abrasion. Both system types are in the experimental phase.

Oxidation wetlands are what most people think of as "wetlands". They differ from sulfate reducing systems in that metals are precipitated through oxidation, and aquatic plants must be established. This treatment method is applicable where the pH of a mine drainage is approximately 6.5 or higher, and where metals concentrations in the drainage are primarily a problem during summer months. Aeration is an important part of this system. The plant materials provide aeration and, when they die, provide adsorption surfaces, along with sites for algal growth.

Aeration is best used where the mine drainage pH is about 6.5 or above. Aeration promotes metal precipitation through oxidation processes. Aeration can be accomplished by mechanical means, or simply by channeling the drainage over rough slopes. Mechanical methods require some source of power, which may be generated through wind, solar cells, or hydro-power. Aeration methods normally include a settling pond below the aeration component.

Mechanical injection of neutralizing agents involves a powered mechanical feeder/ dosing system for dispensing neutralizing agents. This type of system requires frequent maintenance, may produce significant quantities of metal sludges, and should be considered "semi-passive". Power for the feeder can come from wind, solar, or hydro-power. At the Pennsylvania Mine in Summit County, a turbine running in the adit discharge stream demonstrated that hydro power is practical in some situations. Mechanical systems are generally considered only where there are no options for truly passive alternatives. Any high pH material can be used in this type of system. Because of cost effectiveness and sludge characteristics, the most common neutralizing agent used is finely ground limestone.

Dilution is often overlooked as a treatment method. It can be a cost effective method of treatment, because the neutralizing agent is simply uncontaminated water. Clean water is mixed with the mine drainage in a settling pond, and the resultant pH increase initiates precipitation of metals. A drawback to this method is that the percentage of metals precipitated is significantly less than most other methods. Metals removal is site specific, but generally less than 50%. This method is most effective in removing iron, aluminum, copper, cadmium, and lead, but has only slight effectiveness for zinc and manganese.

Electro-Kinetics is a newer semi-passive method to remove metals from mine drainage. There are several forms of this treatment currently being developed. The electro-kinetic method discussed in this report uses a low-maintenance, self-regenerating resin to remove metals from mine discharge. Different metals can be separated by using ion specific resins. Electricity is used to strip metals from the resins, producing a sludge, and allowing re-use of the resin.

Land Application is a method designed to use natural metals attenuation processes in soils and subsoils to remove metals. Plant uptake, evaporation and transpiration, and soil exchange capacity act to tie up and remove metals. This method is most effective where mine discharge can be spread over a large area to infiltrate into relatively thick soils or unconsolidated deposits. Drainage should be neutral or near neutral to avoid plant toxicity. This alternative is also effective for discharges with high iron and/or aluminum, and where pH is approximately 4.5 or above.

SUBSURFACE HYDROLOGIC CONTROLS

Subsurface Hydrologic Controls are in-mine measures that inhibit or prevent the process of acid formation and/or heavy metal dissolution into the ground or surface water system. If it is possible to prevent water from entering a mine, or from coming into contact with sulfide ores or wastes, or mixing with contaminated water plumes in the workings, this can be the best, most cost effective remediation approach, because it helps prevent the problem, rather than treating its symptoms in perpetuity. The success of most hydrologic controls depends on developing a geochemical and hydrologic understanding of the mine-groundwater interactions. Chemical characterization of inflows, and Isotopic and dye-tracer studies can be used to separate mine impacted waters from unimpacted water inflows; to determine travel times and pathways of infiltrated snowmelt and rainfall through ground-water flow systems; and to help develop conceptual understandings of geochemical processes which control the transport and fate of metals in the subsurface. These studies enhance the understanding of the sources and hydrologic pathways of waters that enter the mine workings and discharge from the mine workings through groundwater and surface pathways, and help determine how best to segregate or seal off particular water sources in the workings:

In-Mine Diversions are effective where clean groundwater inflows are degraded by flowing through drifts (veins) and stopes in the mine workings. The concept is to intercept the inflows before they come in contact with metals loading source areas in the mine, thus circumventing metals contaminant production in the mine workings/ ore body. The "clean" inflows are then diverted to the surface stream through a collection and piping system. Though in many cases it may not be possible to intercept all inflows before they become contaminated through contact with the ore body, it is often possible to segregate and divert much of the groundwater inflow before it mixes with the contaminated plume. This can greatly reduce the overall quantity of polluted outflow. By significantly reducing mine discharge, it may then become cost-effective and feasible to treat the segregated contaminate plume through passive or semi-passive techniques; the effluent flow is minimized, and concentration may be adjusted for optimum system performance through dilution with part of the diverted clean flows.

Grout-sealing a fracture inflow zone at a discrete location can prevent groundwater from entering the workings, using proven, existing "ring-grouting" methods and technology. The concept for this technique is to seal water inflows through a grouting program, similar to those used to seal dam foundations, and control water inflows to active underground mining operations. Chemical or cement grout is pumped under pressure into an array of holes drilled radially out from the drift in and along the plane of the water bearing fracture or fracture zones. The grout enters and seals the fracture pathways that communicate with the mine opening. If engineered and executed correctly, the water is prevented from entering the excavation, and is forced far enough back into the rock away from the mine workings so that it resumes its pre-mining course, flowing around the grout "curtain". Depending on conditions and the layout of the workings, care must be taken to ensure the inflows are not simply diverted to a point where they enter another part of the ore body. Ideally, the grout curtain would be in a position where no other lower or upper levels are nearby, and where numerous small fractures or one discrete structure is draining groundwater into the workings along a relatively short section of drift.

Bulkhead Seals are another type of preventive or "source control "measure. The concept is that geochemical and flow equilibrium will be reached in the groundwater, whereupon anoxic conditions in the flooded workings will prevent or reduce dissolution and transport of heavy metals. Bulkhead seals are designed to prevent discharge to surface water through the adit opening by blocking the flow with an engineered hydrologic plug, flooding the mine. For most inactive mines, bulkhead seals are expensive and require considerable geologic and engineering investigation and characterization. Sites that have simple geology, sound rock, and limited subsurface workings may be amenable to this approach.

MINE SITE CHARACTERIZATION

ANIMAS RIVER HEADWATERS AND BURROWS CREEK

Location

The headwaters of the Animas River begin near Engineer Pass approximately 2 miles north of Animas Forks. The headwaters originate as two streams, which join with Horseshoe Creek to form the Animas River. Elevations in the Animas headwaters area range from 13,708 feet in Horseshoe Creek to 11,620 feet at the confluence with the Animas headwaters stream.

Burrows Creek is a tributary to the Animas River located approximately 1 mile north of Animas Forks. Burrows Creek drains the western and northern slopes of Houghton Mountain, entering the Animas 1,500 feet south of Horseshoe Creek. Elevations in Burrows Creek watershed range from 13,052 feet on Houghton Mountain to 11,600 feet at the confluence with the Animas River.

Immediately below the steep headwaters of Burrows Gulch is a trans-basin diversion ditch. During low-flow sampling, the diversion was partially breached. A portion of the stream flow was diverted to the west, but the majority was continuing through Burrows Gulch in the historic channel. During the high-flow sampling, it was observed that the diversion ditch had been repaired, and virtually all the drainage from the headwaters was diverted.

The area is characterized by rugged, steep, high alpine terrain well above timberline. Winters are long with snow depths averaging 440 inches, and the summer growing season is short. Average total precipitation for the past 3 years is 45 inches, 37 inches occurring as snowfall (SGC data).

Mine sites in this area selected by DMG and ARSG for reclamation feasibility studies include the Lucky Jack Mine, an unknown mine above Denver Lake, the Red Cloud and Boston Mine complex, London Mine, Early Bird crosscut, Ben Butler Mine, Prairie Mine, and several unknown prospects on the footslopes of Houghton Mountain. These sites are shown on Figures 3 and 4. The mines are situated on privately owned patented mining claims. Coordinates of each site are given in the individual site descriptions, which follow below.

Geologic Setting

The Animas River Headwaters and Burrows Creek area lie on the northern margin of the Silverton Caldera, in a complex zone of northeast- striking fissure veins (Figure 2). Burns Formation dacite and rhyodacite volcanic flow rocks outcrop at the Lucky Jack area and in Burrows Gulch west of Denver Hill. A younger system of unmineralized northeast-striking faults crosses Burrows Gulch between Denver Hill and the northern slopes of Houghton Mountain, just east of the London Mine. These faults lie along the contact of the Burns rocks and underlying Eureka Tuff member, which outcrops in lower Burrows Creek , and the Animas valley below Horseshoe Creek. The faults bound the margins of a younger intrusive body of rhyolite, which forms Denver Hill and the northern slopes of Houghton Mountain. An east-west striking, unmineralized younger fault intersecting the northeast-striking faults is postulated to underlie the Burrows Creek valley floor.

The younger intrusive rhyolite body has fractured and partly altered the country rock enclosing it. In many places, it is conspicuously flow-laminated and banded, and contains some very porous layers. Some outcrops on Houghton Mountain were observed to be solfatarically altered. The rhyolite weathers to a fine, platy, scree-sized talus, which blankets much of the north slopes of Houghton Mountain and Denver Hill. This intrusive body and its associated faults may create a preferential flow system for groundwater draining through the mines and mineralized ground on the northern and western slopes of Houghton Mountain (see zinc discussion on pg. 21).

A prominently visible fault strikes northeast from the summit of Houghton Mountain, crossing lower Burrows Creek just above its confluence with the Animas. This mineralized structure, named the Denver Fault, continues across the Animas headwaters stream and Horsehoe Creek, crossing into Hurricane Basin through Denver Pass. In the pass, it offsets Burns Formation dacite flows against the older Eureka Tuff. The fault has a normal sense of movement, dips steeply north, and is marked by numerous prospect pits and adits.

Mineralized veins mined in this area strike northeast, tangential to the northern margin of the caldera structure. All the prominent mineralized structures continue northeasterly across Seigal Mountain and into the Henson Creek watershed. The veins are vertical or steeply southeast dipping, with normal sense of movement downward toward the southeast.

For much of its length, the headwaters of Burrows Creek near the Red Cloud Mine flows directly in a mineralized fault system. Some of the metals in the headwaters can probably be attributed to this complex vein system. Resistant outcropping ribs of white quartz along these vein structures have channeled the head waters of Burrows Creek into its present position. The trans-basin diversion collects the flow from the headwaters above the junction of the vein and the valley bottom. Where the fault-vein system crosses the valley bottom, there are numerous seeps and springs. It is likely that groundwater flowing in and along this structure is the source of most of the metals measured at sampling site BG-2 during the high-flow sampling, and is the principle source of the increase in loading between sampling sites BG-1 and BG-2 during the low-flow sampling.

A multitude of north to northwest striking veins occurs north of the Denver Fault through Denver Hill and Denver Lake. Several of these veins were observed to intersect northeast-striking veins at nearly right angles. Numerous prospect pits and adits were developed to explore these veins, but none of the major workings in the area occur on them. The unknown prospect adjacent to Denver Lake appears to have explored a short northwest striking vein.

There are numerous small to medium sized mines with no apparent surface discharge on both sides of Burrows Creek. Many of the shafts and open cuts are flooded with standing water, which may be draining to the adits along the lower valley walls of Burrows Creek. Most of the mine waste piles in this area are apparently acid forming with vegetation kill zones below them. Three of the non-surface discharging mine sites were selected for mine waste pile leachate analysis. These mines were sampled as waste rock sites 20 (Ben Butler Mine), 21 (Boston Mine) and 22 (Red Cloud Mine). The Red Cloud and Boston waste dumps are located in the southwestern portion of Burrows Creek above the trans-basin diversion. The Ben Butler waste site #20 is located north of the London Mine on a south facing slope. All the waste rock sampling sites have large vegetation kill zones, although only site #20 had a high total acidity. The difference in the leachate testing is probably due to the relative content of fine and coarse materials. The waste rock at the Red Cloud and Boston sites #21 and #22 was relatively coarse, while the waste rock at site #20 (Ben Butler), was relatively fine.

Animas River Headwaters and Burrows Creek Site Descriptions

Unknown Prospect North of Denver Lake

Location
This site is located near the headwaters of the Animas River approximately 300 yards northwest of Denver Lake at an elevation of 12,080 feet. This site is believed to be on BLM land. This site was sampled as water quality station DM-1 and as waste rock site #16 (Figure 4). Stream stations UA-1 and UA-3 bracket the mine site (Figures 3 & 15). The site is located at LAT. N37°57'19.6", LONG. W107°34'38.6".

Workings
A short adit was driven west into the basin wall. The open adit was observed to flow 0.1 to 2 gallons per minute (gpm) onto the waste pile. The waste rock was cast to the east side of the steep slope, extending to within 50 yards of the small stream.

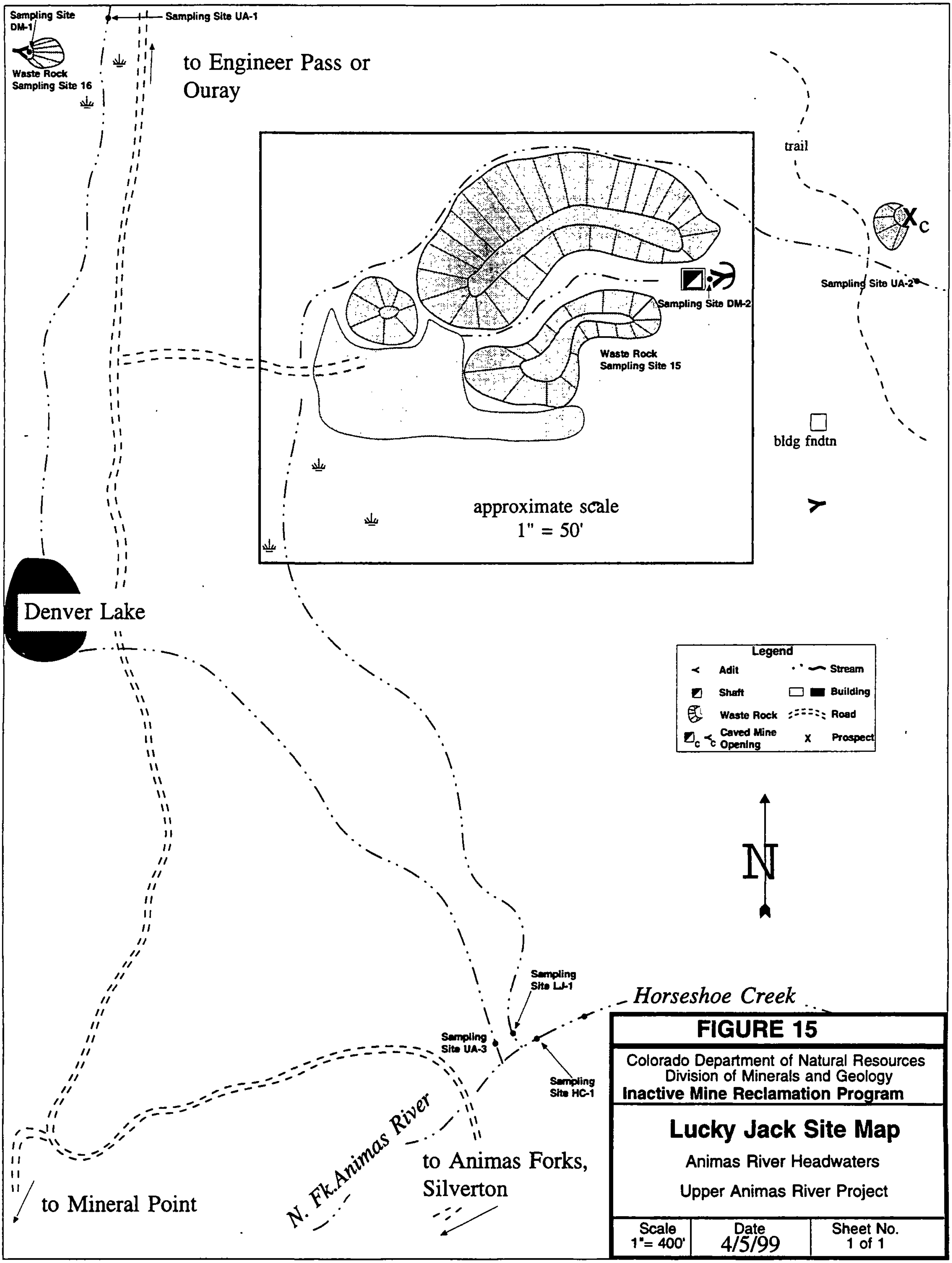
Mine Wastes
The waste rock pile is steep sided, containing approximately 400 cubic yards of fine to coarse country rock containing small amounts of pyrite and sphalerite. The waste rock had acidity and metals concentrations in the leachate similar to the undisturbed talus and soils in the watershed. There was only a small zone below the waste pile where vegetation was stressed, possibly due to erosion of the waste onto the surrounding soil. The results of the leachate analysis are given below

Unknown Prospect North of Denver Lake

pH s.u.	Total Acidity mg/l	Al Ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
4.04	78	35	1	4	120	9	57	150

Historic Structures
There are no structures or equipment, other than scattered debris.

Water Quality Impacts
Water quality impacts from this site are principally from the adit discharge. This prospect drains approximately 0.2 to 2 gpm of pH 3.8 to 4.1 water. As the mine drainage passes through the mine waste pile, it appears that metals are removed rather than leaching additional metals. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.02-0.14% of the dissolved heavy metals. The stream that receives the drainage from this mine has an apparently healthy, reproducing brook trout population. The measured metal loadings from this mine are given below.


Sampling Site DM-1
Sampling Site UA-1
Waste Rock Sampling Site 16
to Engineer Pass or Ouray
trail
Sampling Site UA-2
Sampling Site DM-2
Waste Rock Sampling Site 15
bldg fndtn
approximate scale 1" = 50'
Denver Lake
Legend
Adit
Stream
Shaft
Building
Waste Rock
Road
Caved Mine Opening
Prospect
N
Sampling Site LJ-1
Horseshoe Creek
Sampling Site UA-3
Sampling Site HC-1
N. Fk.Animas River
to Animas Forks, Silverton
to Mineral Point
FIGURE 15
Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program
Lucky Jack Site Map
Animas River Headwaters
Upper Animas River Project
Scale 1"= 400'
Date 4/5/99
Sheet No. 1 of 1

Unknown Mine North of Denver Lake

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low -Flow	0.54	BDL	0.03	0.05	0.72	0.28	0.32	3.62
High-Flow	2.3	BDL	0.2	0.3	20.0	3.5	1.1	21.9

Reclamation Options

No reclamation is recommended for this site. This mine apparently has a minor effect on the water quality of the Animas River headwaters. If any reclamation is done to this site, it should be limited to construction of an anoxic limestone drain to raise the pH of the adit discharge. This can be done concurrently with safeguarding the mine opening.

Lucky Jack Mine Site

Location

This site is located on a relatively flat area east of the Engineer Pass Road northeast of Denver Lake (Figure 16) The mine site is located at an elevation of 12,000 feet. This site is believed to be on the Lucky Jack, Silver Maid and Black Jack patented mining claims. This site was sampled as water quality station DM-2 and as waste rock site #15 (Figures 3 & 4). Stream stations UA-2 and LJ-1 bracket the mine site. There is an old access road to the site. The site is located at LAT. N37°57'14.7", LONG. W107°34'19.5".

Figure 16. Lucky Jack Mine Site

Geology and Mine Workings
The Lucky Jack mining site consists of an open, flooded adit driven east-northeast into the shallow sloping foot of Seigal Mountain, a flooded shaft immediately adjacent to the main adit, an upper collapsed adit 300 feet northeast of and 52 feet above the lower adit, and an open prospect shaft approximately 30 yards south of the main adit (Figures 15 & 16).

The mine was investigated by V.C. Kelly in 1946, when the workings were still accessible (Kelly, 1946). He reports:

The Lucky Jack Mine lower adit is at an elevation of 11,992 feet, and it is approximately 500 feet long from portal to face. The upper adit is branched, but only 100 feet in aggregate length (Figure17).

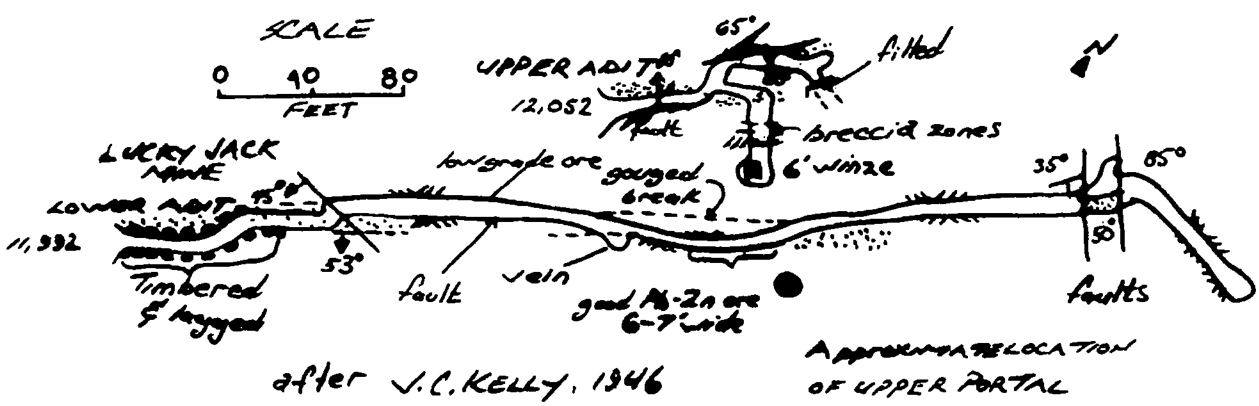


Figure 17. Plan of the Lucky Jack Mine, from Kelly, 1946

The vein strikes N. 61° E. and is mostly vertical in dip, but local dips of 53° SE. and .80° NW. have been noted. The vein varies from 3 to 25 feet in width. The workings appear to deliberately avoid the hard quartz sulfide part of the vein, instead following a much softer gougy zone on the north side of the fissure. About 320 feet from the portal, the tunnel jogged left off the vein and never got back on it, except for a short 15 foot section where it was faulted back into the heading, quite by chance. About half way to the face, the adit turned east and followed the vein for about 80 feet, disclosing a shoot of fair lead-zinc ore 6 to 7 feet wide. The upper workings are roughly over this section, where the vein is nearly 25 feet wide, but the base metal content is not high. Some of the vein material in the lower adit is intricately banded and cross-banded as a result of repeated filling and opening of the fissure. Thin dark and light bands of quartz make up striking veins incorporating earlier vein and rock fragments. Recorded output of metals from the mine for the years 1928, 1937, and 1939 were 72 total tons, which yielded 9.18 oz. Gold, 363 oz. Silver, 429 lbs. Copper, 9,380 lbs. Lead, and 4,624 lbs. Zinc.

The Lucky Jack vein structure appears to be the northeast ward extension of the Broad Gauge/ Black Jack vein system, which swings through the saddle north of Denver Hill.

Mine Wastes

Most of the mining waste at the Lucky Jack site is located in scattered piles near the main adit. Much of the original mining waste pile has been flattened to provide a dry staging area for the mine. There is also a small waste rock pile at the small adit northeast of the main adit that extends into the perennial stream. The mine waste piles at this site have an approximate volume of 2,800 cubic yards. The mine waste is fine to coarse grained rock containing pyrite, sphalerite, and some galena. Waste rock leachate analysis indicates that this waste rock is acid forming. Selected results from the leachate analysis are given below.

Lucky Jack Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
2.86	1298	3300	130	610	2900	6800	4400	20000

Historic Structures

There are no structures or equipment, other than scattered debris.

Geologic Constraints to Reclamation

There are no site specific geologic hazard constraints to reclamation, with the exception of potential snow avalanches from the steep west face of Seigal Mountain. Boggy areas and an apparent shallow groundwater table may affect excavation and waste burial options. There are some available disposal sites with thicker colluvial and unconsolidated materials on the lower slopes of Seigal Mountain, as described above. Stabilizing the adit and gaining access to water inflows for source controls could be complicated by the fact that parts of the workings followed a gouge zone just off the vein. These conditions could mean a weak back, with attendant ground control problems in some parts of the workings.

Water Quality Impacts

Water quality impacts from this site are from leaching of the waste rock and the adit discharge. The only adit discharge comes from the main adit although the shaft outside the main adit is flooded. The shaft is believed to be flooded by drainage from the main adit. The measured flow from the adit varies from 2.5 to 45 gpm of pH 3.9 to 5.1 water. The flow measured during the high-flow sampling was less than measured during the high-flow sampling. This is possibly due to lag time between snowmelt and when water enters the mine workings. If water freezes in shallow fracture systems, it will melt at a later date than the snow.

Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.31-1.28% of the dissolved heavy metals and approximately 3% of the dissolved zinc during high-flow. During high-flow, the metal loading from this site, as measured at station LJ-1 is much greater than the load measured at the adit. This data shows that there is significant leaching of metals from the waste rock. Much of the waste rock was graded into a wetland area. Also, the perennial stream passes beside and through the waste rock from the main adit, and a portion of the waste rock from the collapsed adit northeast of the main adit is in the stream channel during high-flow.

During low-flow, there is a decrease in metals loading between stations DM-1 and LJ-1. This is probably due to less leaching of the waste rock during low-flow. It is believed that there is much more precipitation of metals occurring in the stream during low-flow because of the reduced flow and reduced velocity. We have observed, during numerous visits to this site, that the waste rock graded into a flat area is wet throughout the year. During low-flow, the adit discharge has been observed to infiltrate the waste rock before it reaches the stream.

Heavy metals loading from the Lucky Jack adit and at station LJ-1 are given below. Station LJ-1 is located approximately ¼ mile south of the Lucky Jack Mine.

Lucky Jack Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low -Flow	64.52	BDL	0.94	4.70	47.96	56.86	30.16	228.67
High-Flow	15.0	BDL	0.4	1.0	23.8	3.2	7.1	61.1

Sampling Station LJ-1

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low -Flow	BDL	BDL	BDL	BDL	14.01	BDL	2.34	70.05
High-Flow	126.55	BDL	6.70	BDL	88.26	171.74	0.00	591.22

Reclamation Options

Reclamation of this site should be completed in two phases. The first phase is to remove the waste rock from the wetland to a relatively high and dry site, or remove it to a waste repository. There are two potential removal sites nearby. The first is located approximately 50 yards north of the main adit along a south facing hillside. The second is located approximately 50 yards southeast on a west facing slope. The site north of the main adit appears to be preferable if it is not a snow accumulation area. The north site can be graded in a manner that blends in with the surrounding terrain. Soils in the northern site are much deeper, which will greatly aid in revegetation. There may be sufficient soil at the north location to allow for covering the waste rock removal and disposal areas. The snow drifting patterns need to be investigated early in the summer to determine whether the north site is suitable. The south site is very rocky. This will result in a mounded final configuration.

The waste rock removal area will most likely have to be amended with ground limestone to neutralize the accumulated acidity in the wetland. Exposing the peat material under the waste rock will cause increased release of metals the season following waste removal. Limestone addition and covering the removal area with soil will help to reduce oxidation and release of heavy metals from the wetland peat.

Following reclamation of the waste rock, the mine adit should be re-opened. It appears likely that most of the water draining from the mine enters the mine workings from the perennial stream. The mine workings appear to go under or pass near the stream within a relatively short distance from the mine entrance. If there are discreet locations where the water enters, the fracture systems can be grouted to prevent flow into the mine workings. Since the workings are flooded near the entrance, a small pond will have to be built to treat the water as it is drained from the mine.

There are very few treatment options if the mine drainage cannot be stopped by grouting the fractures systems. The elevation of the mine precludes construction of a sulfate reducing wetland outside the adit. Neutralization using a mechanical system would be costly to construct, since there is no viable power source available nearby, except solar power. The pH of the adit discharge (4-5) is marginal for construction of an anoxic limestone drain. There would be some benefit to constructing a settling pond outside the adit since iron will precipitate and result in some co-precipitation of zinc. An anoxic limestone drain would likely improve metals reduction in a settling pond.

Little Chief Mine

Location
This site is located near the headwaters of the Burrows Creek on the northwestern flank of Houghton Mountain at an elevation of 12,120 feet. This site is believed to be on the Little Chief claim. This site was sampled as water quality station DM-3 (Figure 3). The mine site is believed to be bracketed by stream stations BG-1 and BG-2. The site is located at LAT. N37°56'56.5", LONG. W107°34'53.7".

Geology and Mine Workings
A short adit was driven southeast into Houghton Mountain, probably to intersect the Sewell-Big Giant vein system. This structure strikes northeast and dips vertical to steeply southeast. It is the northeastern extension of the Burrows-Yankton vein, which crosses over into Burrows Creek from California Gulch, through the saddle on the west shoulder of Houghton Mountain. Outcrops just above the portal are hydrothermally altered intrusive rhyolite and older dacite flows. Rock on the dump indicated that the adit workings were advanced from Burns Formation dacite into the intrusive rhyolite body on the north slope of Houghton Mountain. The rhyolite observed on the dump was altered, and partly pyritized.

The open adit flowed 2.5 gpm during the low-flow sampling. During the high-flow sampling, the adit could not be located because the adit and waste rock pile were both still covered with snow. The adit discharge quickly infiltrates into the mine waste and talus below the portal. It is not known whether the mine drainage enters Burrows Gulch above or below the trans-basin diversion.

Mine Wastes
The waste rock pile contains approximately 700 cubic yards of fine to coarse rock containing pyrite and considerable ruby sphalerite. The waste rock was not sampled, but visually, is similar to sampling site #21 and #22. The waste rock contains pyrite and ruby sphalerite. There is a small kill zone below the waste pile.

Historic Structures
There are no structures or equipment, other than scattered debris.

Geologic Constraints to Reclamation
Loose talus and scree mantle steep slopes throughout the site, which is subject to continuous rock-fall and avalanches from the slopes of Houghton Mountain. There is no potential for any treatment systems or options on the steep slopes. Mine discharge would have to be collected and piped down slope for possible treatment on the valley floor, or alternatively, treated inside the adit prior to discharge.

Water Quality Impacts
Water quality impacts from this site are principally from the adit discharge, although the mine drainage may pick up additional metals as it passes through the waste rock. The low-flow discharge measurement was 2.5 gpm of pH 3.5 water. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.88% of the dissolved heavy metals during low-flow but about 7% of the dissolved aluminum. The adit discharge produces approximately ¾ pounds of metals per day during low-flow. The measured metal loadings from this mine are given below.

Little Chief Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low -Flow	94.70	BDL	0.31	2.22	52.75	0.06	91.49	58.25

Reclamation Options
This site has not been adequately characterized to recommend a reclamation method. The mine is located near the top of a large talus deposit. It is likely that a portion of the mine drainage is flowing through the talus into the groundwater. The mine should be completely opened to allow for free flow of the adit discharge and sampled during high-flow. High-flow will most commonly occur at this site in mid to late-July.

Early Bird Crosscut Site

Location
This site is located on a steep north-facing slope on the north flank of Houghton Mountain. The mine is located directly south of the London Mine at an elevation of 12,040 feet. This site is believed to be on the Paris patented mining claims. This site was sampled as water quality station DM-4 and as waste rock site #19 (Figures 3 & 4). Stream stations BG-2 and BG-3 bracket the mine site. There is an old overgrown access road to the site. The site is located at LAT. N37°56'46.0", LONG. W107°34'57.9".

Geology and Mine Workings
There is one collapsed adit and one open adit at this site. Both adits are driven southwest into Houghton Mountain along a mineralized fault in the Eureka Tuff. The vein structure might be part of the McIntyre vein system (Kelly, 1946). The lower of the two adits drains up to 17 gpm. These workings are associated with the Early Bird Mine, which developed the Queen of the West Vein a little farther west on Houghton Mountain. Kelly, 1946, reported that the 12,040 elevation adit was a cross cut to the Early Bird workings which was started but never completed. The intent was apparently to gain better access to the Queen of the West Vein in the Early Bird Mine higher up the slopes of Houghton Mountain.

Mine Wastes
The waste rock at this site is a white to light yellow fine-grained fault gouge. The waste rock pile is steep sloped with and estimated volume of 2,900 cubic yards. There was very little primary mineralization found in the waste rock, but there were visible secondary iron and zinc sulfides. Leachate analysis indicates that this waste rock is not particularly high in heavy metals. There is a vegetation stress zone below the waste pile that may be due to erosion of the mine waste. Selected results from the leachate analysis are given below.

Early Bird Crosscut

pH s.u.	Total Acidity Mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.24	49	1400	3	220	1000	430	17	210

Historic Structures

There are no structures or equipment, other than scattered debris.

Geologic Constraints to Reclamation

Minor rock-fall and potential snow avalanches from the steep slopes of Houghton Mountain affect the site. Bedrock outcrop covers the entire area, so there is little potential for excavation or cover materials.

Water Quality Impacts

Water quality impacts from this site are principally from the adit discharge. It appears that metals are removed as the adit discharge flows through the mine waste. The measured flow from the adit varies from 1.5 to 17 gpm. The pH of the adit discharge was measured at 3.6 during low-flow and 4.4 during high-flow. The adit discharge is principally a source of aluminum, although it produced about ¼ pound of zinc per day during high-flow. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.04-2.68% of the dissolved heavy metals and up to about 10% of the dissolved aluminum. Compared to the groundwater inflow loading that occurs in the stream segment containing this mine, the adit discharge is an insignificant source of metals. The adit discharge has similar metals concentrations as the stream in Burrows Creek, with the exception of iron.

Heavy metals loading from the Early Bird adit are given below.

Early Bird Crosscut

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low -Flow	4.49	BDL	0.01	0.19	2.16	0.06	4.93	1.69
High-Flow	445.7	BDL	1.5	33.0	173.8	2.2	189.6	112.3

Reclamation Options

No reclamation is currently recommended for this site. The adit discharge is thought to be an insignificant source of metals to Burrows Creek, and may be nearly identical to the groundwater inflow background. The adit discharge does have a significantly higher iron concentration, but most, if not all, of the iron should precipitate as the mine drainage passes through the waste rock. The waste rock also does not appear to be a significant source of metals. The major problem with the waste rock appears to be erosion of the waste into the valley bottom. There does not appear to be much run-on water that affects the pile, so most of the erosion must come from summer thunderstorms.

London Mine Site

Location

This site is located on the north side of Burrows Creek near the edge of a large wetland area. The mine is located at an elevation of 11,910 feet. This site is believed to be on the Washington, Wicker and Greenfield patented mining claims. This site was sampled as water quality stations DM-5, DM-6, and DM-7 and as waste rock site #18 (Figures 3 & 4). Stream stations BG-2 and BG-3 bracket the mine site (Figure 19). The main access road into Burrows Creek passes through the site. The site is located at LAT. N37°56'54.4", LONG. W107°34'58.7".

Geology and Mine Workings

There are two collapsed adits, a collapsed shaft, and one open, safeguarded adit at this site. Sampling site DM-5 (the westernmost adit) is a short adit that has caved (Figure 18). Sampling site DM-6 is a short adit/stope driven northeast into the hillside toward the main London Adit. The main adit (station DM-7), is safeguarded with a grated bulkhead seal. The main adit is a crosscut driven northward into the hillside in competent dacite and rhyodacite flows of the Burns Formation. All three adits drain perennially.

The mine was investigated by V.C. Kelly in 1945. (Kelly, 1946). He reports:

> *The London Mine portal is at an altitude of 11,910 feet. The mine comprises two sets of workings, on two different veins. It was located in 1877, and prior to 1900 was operated through a shaft on a vein of N. 30° W. strike This "London" vein was prospected on above the road and has been followed for a short distance at the entrance of the main adit (Figure 18).*

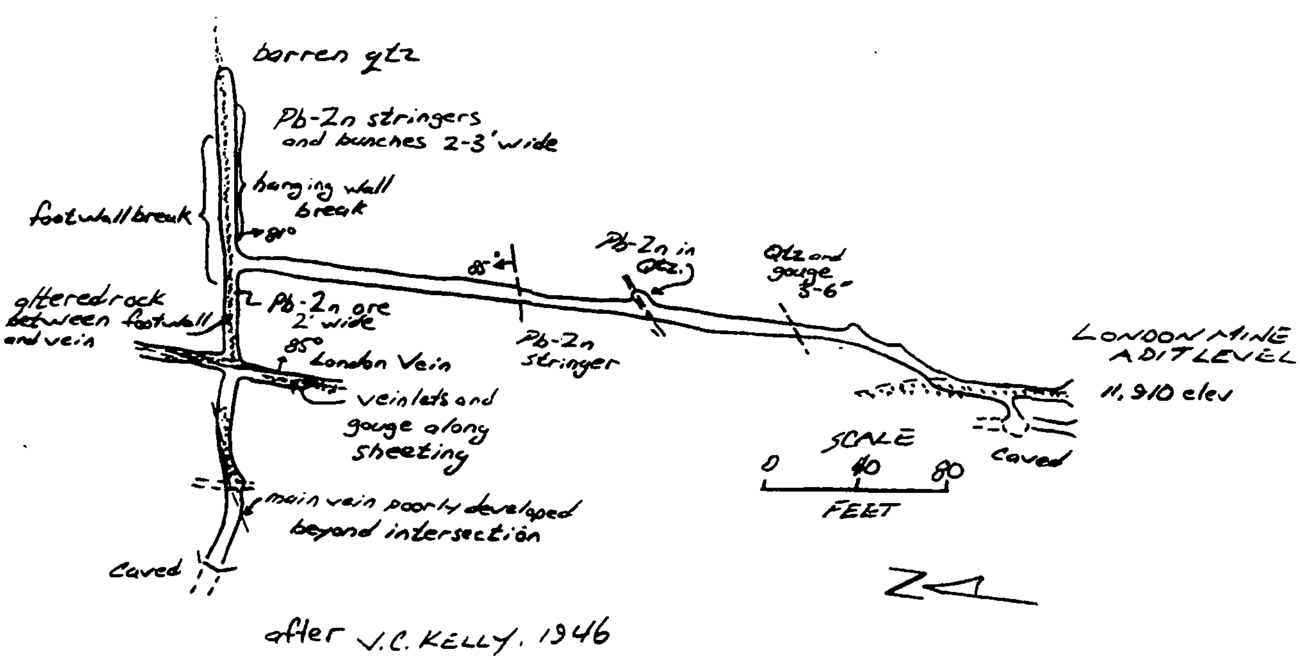


Figure 18. Map of the London Adit, from Kelly, 1946

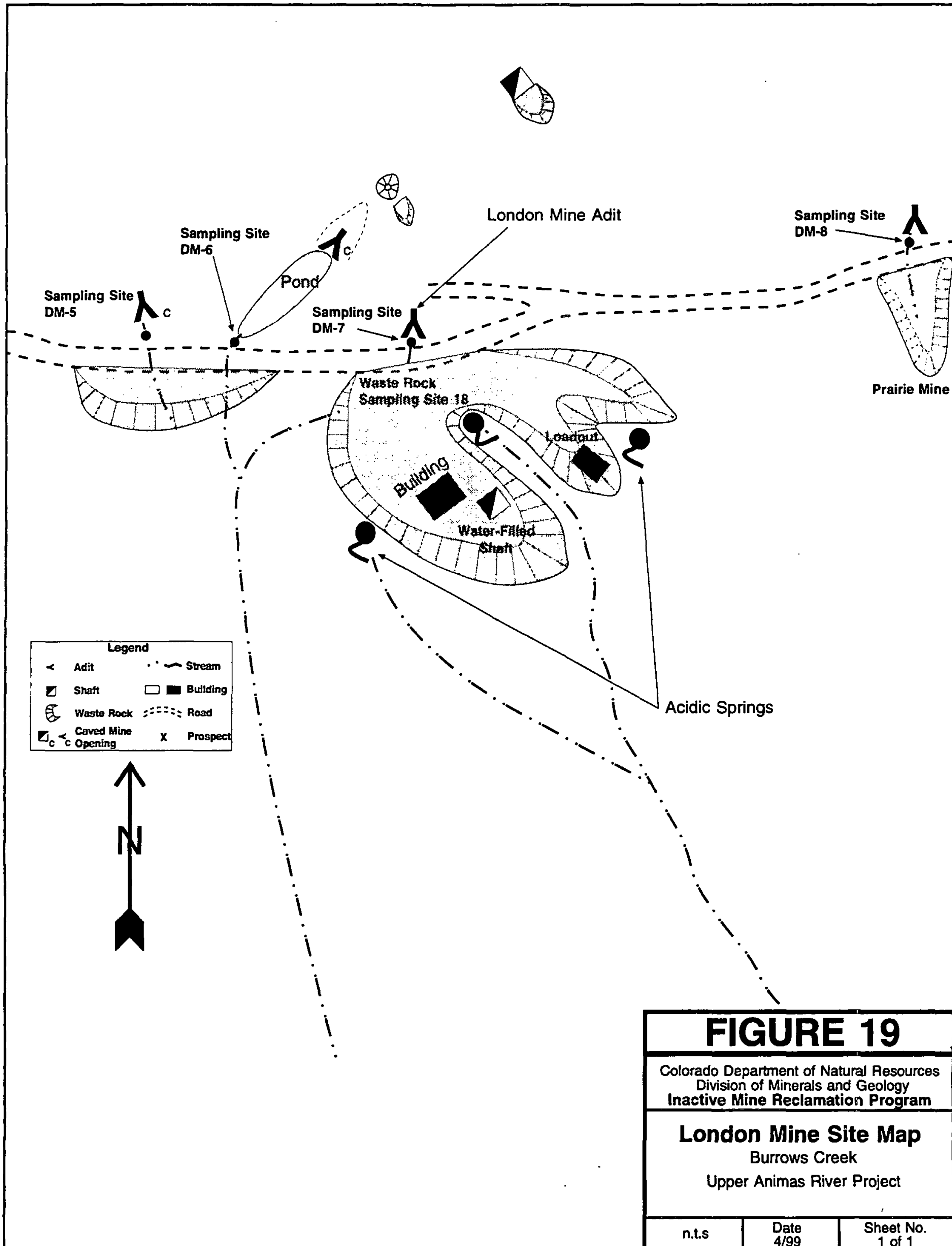


FIGURE 19

Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program

London Mine Site Map
Burrows Creek
Upper Animas River Project

n.t.s	Date 4/99	Sheet No. 1 of 1

It is cut again in the drift workings on the London adit level, where it dips 85° E. The shaft is reported to be about 180 feet deep, with 100-foot and 200-foot (bottom) levels. Drifting extended 200 feet south and 100 feet north on the 100 level, but only short drifts are on the bottom level. Some of the ore contained as much as 3 oz./ton gold. The shaft vein was 8 feet wide with a pay streak up to 2 feet wide. Sometime between 1900 and World War I the London Tunnel (adit) was driven, and at this time some ore was shipped to the Silver Wing mill. The London adit level consists of a 380-foot crosscut to drifts aggregating over 300 linear feet. The principal drifting is on the Washington vein, a southwest extension of the Ben Butler vein. This vein strikes about N. 50° E., and dips .80°-90° SE. It is thought to apex on the Washington claim. Over 100 feet of fairly good lead-zinc ore ranging from 1 to 3 feet in width is exposed in the London drift. No stoping has been done. Toward the southwest end of the drift the lead-zinc streak pinches to a few inches and in the London vein, which was drifted on for about 70 feet, only 1 to 2 inches of lead-zinc ore is present. On the main Washington vein, the lead-zinc ore shoot lies along the hanging wall; it is separated from the prominent footwall break by 1 to 4 feet of altered andesite/dacite. The northeast end of the London drift is about 1,000 feet from the Ben Butler shaft. The vein at the face of the northeast drift consists of barren quartz about 6 feet wide. Ten samples taken from across the vein 5 to 6 feet wide are reported to average 0.02 oz./ton gold, 3.5 oz./ton silver, 3% lead, and 6.5% zinc. The only record of production from the mine is for 1921, when 11 tons of ore yielded 1 oz. Gold, 336 oz. Silver, 368 lbs. copper, and 1,122 lbs. lead.

Mine Wastes
The waste rock at this site is a yellow, coarse to fine-grained sulfide waste. A portion of the waste rock extends into a historic wetland, and exhibits several acidic springs/seeps. The waste rock contains pyrite, sphalerite, and galena in a quartz matrix. The waste rock pile contains approximately 3,300 cubic yards of material. There is a small vegetation kill zone located below the pile. Selected results from the leachate analysis are given below.

London Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu Ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.34	30	230	10	140	830	270	4000	1700

Historic Structures
There is a small log building on the waste rock pile in good condition, and portions of a loadout structure on the site.

Geologic Constraints to Reclamation
There are no specific geologic hazards affecting the site. It is beyond avalanche runout zones from Houghton Mountain, and is situated on relatively gently, rocky slopes. There is little available in the way of unconsolidated materials for excavation or covering work.

Water Quality Impacts

Water quality impacts from the London Mine occur from the adit discharges and the waste rock pile. The measured flow from the main adit (DM-7) varies from about 1 to 1.5 gpm. The measured flow from adits DM-5 and DM-6 vary from 0.15 to 6.5 gpm and 0.15 to 3.6 gpm, respectively. The pH of the adit discharges were near neutral. Drainage from the adits flows across a road constructed of waste rock into the adjacent wetland, bypassing most of the waste rock pile. The adit discharge from the main adit does come in contact with the westernmost lobe of the waste pile. Drainage from the main mine adit produces more metals than either of the other two draining adits. In aggregate, compared to all the adit discharges in the Upper Animas River, these adit discharges produce 0.2 to 0.34% of the dissolved heavy metals. The adit discharges produce approximately 0.1 to 0.25 pound of dissolved metals per day. Zinc is the principal dissolved metal in these drainages.

The waste rock is generally high in lead and zinc. It is likely that most of the lead, leached from the waste pile, is precipitated in the wetland before it reaches the stream. There are several seeps and springs at the base of the waste rock pile. The flow from these springs is too low to be sampled by conventional means. The aggregate flow from the springs visually appears to equal or exceed the flow from the mine adits. The source of these springs is presently unknown. The springs may be from mine drainage flowing through the fracture systems or background water. There are numerous springs along the valley bottom, which would tend to indicate that the source is groundwater inflow.

Heavy metals loading from the London Mine are given below.

London Mine DM-5

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low -Flow	BDL	BDL	BDL	0.00	0.01	BDL	0.00	0.02
High-Flow	BDL	BDL	0.2	1.0	6.3	1.0	0.3	23.8

London Mine DM-6

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low -Flow	0.32	BDL	0.02	0.09	1.39	0.09	0.89	4.44
High-Flow	BDL	BDL	0.2	0.6	4.6	1.8	2.0	24.7

London Mine Main Adit DM-7

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low -Flow	BDL	0.02	0.31	0.06	3.61	BDL	8.43	48.14
High-Flow	BDL	BDL	0.3	0.1	2.4	BDL	7.3	46.4

Reclamation Options

The London Mine appears to be an insignificant source of metals to Burrows Creek compared to the groundwater inflow loading. As an example, during low-flow and high-flow, the zinc loading between sampling sites BG-2 and BG-3 is approximately 3,300 grams per day. All the adit discharges within this segment produce approximately 115 and 215 grams of zinc per day during low-flow and high-flow, respectively. The adit discharges at the London site produce approximately half the zinc load from all the mines in this segment.

If reclamation is contemplated at the London Mine, it is recommended that anoxic limestone drains be installed in all three adits. A small settling pond can be constructed in the vegetation kill zone adjacent to the road or the drainage can be ditched directly into the wetland.

Additional monitoring of the site is necessary to determine the metals loading from the waste rock pile. The monitoring can be done by drilling groundwater wells in the waste rock pile adjacent to the road, and near the toe of the pile. Conversely, the pile can be sealed off by grout injection along the road and at the bottom of the pile. Runoff water can be improved by applying limestone, lime or fly ash to the surface of the pile.

Ben Butler Mine

Location

There are several small mine sites on the north side of Burrows Creek that have large vegetation kill zones below them. The Ben Butler site was sampled as a representative site. The mines and small prospects in the area are shown on Figure 20. These mines are scattered over the hillside. The Ben Butler mine is located north of the London Mine near the hilltop approximately 1,200 feet west of Denver Hill at an elevation of 12,200 feet. There are no roads to this site. The waste rock pile was sampled as site #20 (Figure 4). The site is located at LAT. N37°57'06.7", LONG. W107°34'59.5".

Figure 20. – Northern Slope of Burrows Creek – London Mine at lower left, Ben Butler Mine at upper right-center

Geology and Mine Workings

Mine workings at the Ben Butler site include two shafts and three stopes. The shafts and stopes are all water filled. The shafts are inclined southeast and follow the vein in altered Burns Formation dacite and rhyodacite flows.

The mine was investigated by V.C. Kelly in 1945. (Kelly, 1946). He reports:

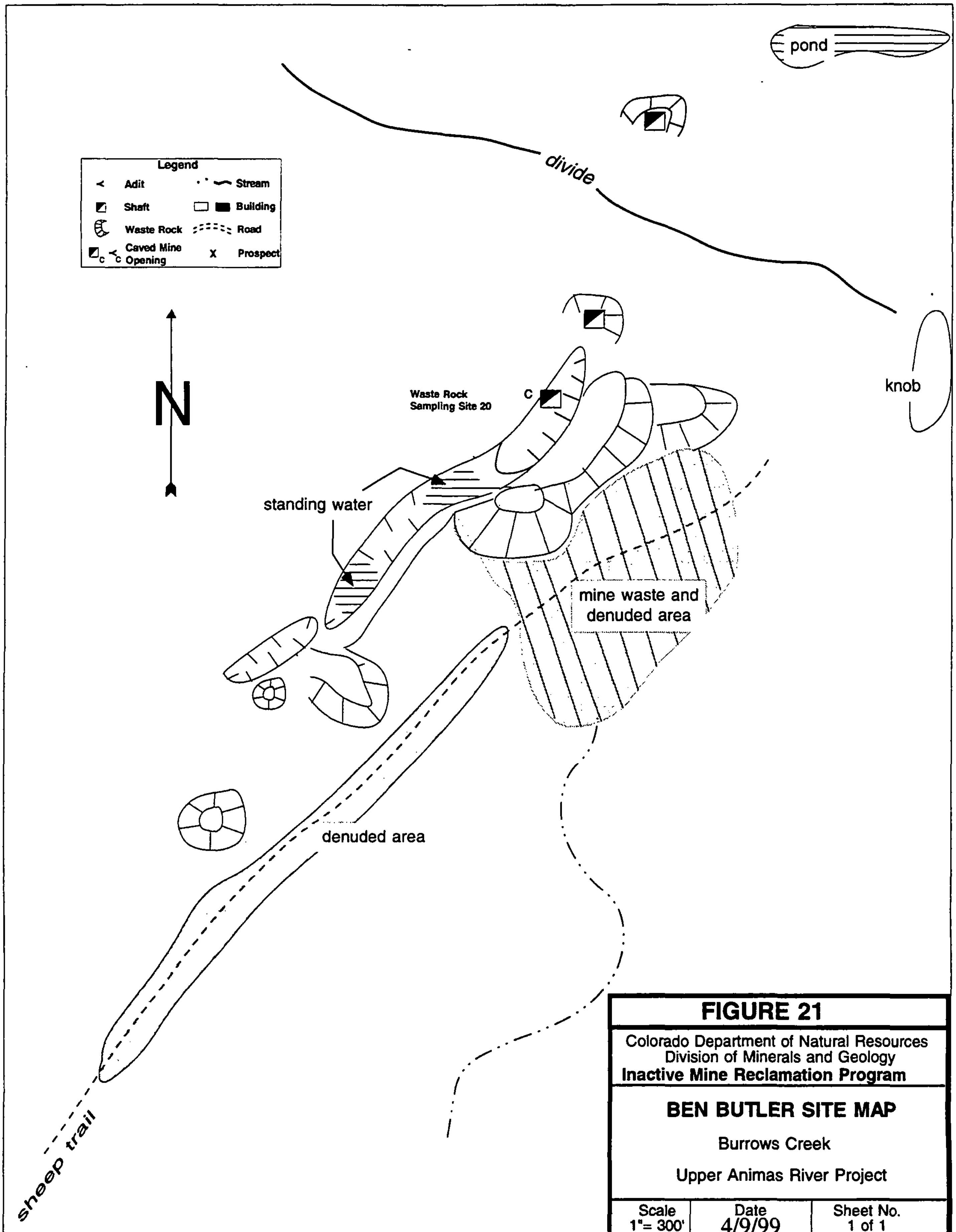
> *The Ben Butler mine workings are developed through a main shaft 125 feet deep. Water stands to within 15 feet of the collar, and in the numerous small pits, cuts, and trenches dug along the lode in both directions from the shaft. Some stoping along the vein is also evident. The vein strikes N.45° E. and dips 70° to 75° SE. At the shaft and in the cut southwest of it, the lode is nearly 20 feet wide, and stoping at this point is in an ore shoot about eight feet wide along the hanging wall. This shoot lies above a hard quartz rib along the footwall. About 2 feet from the footwall there is a small galena streak 3 to 4 inches wide. To the north, the main ore shoot and the stope cut diagonally across the footwall side of the vein. The lode is lenticular, narrowing to about 2 feet in width and splitting into stringers on either side of the shaft. At the narrow ends of the ore shoot, only thin seams and stringers of galena with no sphalerite occur. Much mill-grade lead zinc ore remained on the dumps east of the shaft and cuts. The best ore is the finely crystallized galena and ruby silver (proustite) in a quartz gangue. Pyrite occurs irregularly through the vein, and a little marcasite in thin seams is also present. The shipping ore of the early activity is said to have contained 40 oz./ton silver 40% lead, and up to 4 oz./ton gold. In 1894-95 shipments totaling 480 tons averaged 0.11 oz./ton gold and 140 oz./ton silver. A shipment of 1,038 sacks of high-grade ore sent to the Public Sampling Works in Silverton averaged 0.38 oz./ton gold and 168 oz./ton silver. Most of the mining was done prior to 1900, although some work was ongoing in 1900. In 1916 ore totaling 174 tons was milled, and resulted in concentrates which yielded 9.34 oz. gold, 1,559 oz. sliver, 1,203 lbs. copper, and 21,482 lbs. lead.*

<u>Mine Wastes</u>
The waste rock at this site consists of an estimated 400 to 600 cubic yards of fine clayey to gravelly-sized quartz-sulfide waste. Ore on the dump is similar to the London mine ores, consisting of coarse-grained greenish sphalerite with some galena, and intergrown pyrite and chalcopyrite, with associated vuggy, white quartz. Secondary sulfosalts and crusts were observed. There is a distinctive sulfur odor from the dump, and hydrothermally altered zones were seen along the vein in the country rock. Heavy iron hydroxide precipitates coat the internal walls of the shaft.

A 200-yard long vegetation kill zone extends downslope from the waste dump and becomes a drainage channel from the disturbed site into Burrows Creek (Figure 21). The waste around the collar of the northeastern-most shaft has a small kill zone which drains directly into the pond adjacent to the shaft. It is possible that the standing water observed in the workings is subsurface leakage from this pond, as the Ben Butler vein structure, and possibly some workings, continue northeastward beneath it.

The waste rock at this site had the highest concentrations of aluminum, cadmium, iron and zinc found in the Animas River above Eureka.

There are vegetation kill zones below virtually every waste rock pile along the north slope of Burrows Creek. The mineralogy of the waste piles is similar to that sampled at the Ben Butler, but many of the piles contain coarser materials.


pond
divide
Legend
Adit
Stream
Shaft
Building
Waste Rock
Road
Caved Mine Opening
Prospect
knob
N
Waste Rock Sampling Site 20
C
standing water
mine waste and denuded area
denuded area
sheep trail
FIGURE 21
Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program
BEN BUTLER SITE MAP
Burrows Creek
Upper Animas River Project
Scale 1"= 300'
Date 4/9/99
Sheet No. 1 of 1

Selected results from the waste rock leachate analysis are given below.

Ben Butler Mine

pH s.u.	Total Acidity Mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
2.63	552	12000	350	3500	97000	530	3000	71000

Historic Structures
There are no historic structures other than the short timber collars on the two shafts, and scattered metal and wood debris. An iron pipe still sticks up from the collar of the main shaft.

Geologic Constraints to Reclamation
There are no specific geologic hazards affecting the site, as it is in a saddle, and not affected by steep slopes. There is little available in the way of unconsolidated materials for excavation or covering work, as bedrock is essentially at the surface. Two small ponds mark the northeast boundary of the site.

Water Quality Impacts
Water quality impacts occur from this site and similar sites during snowmelt and precipitation events. Drainage from the slope above the waste piles flows directly onto the waste rock. The water in the stopes and shafts may also be a portion of the mine drainage from the London Mine.

Reclamation Options
Diversion ditches should be constructed around the waste piles and vegetation kill zones to reduce impacts from these sites. In most cases, the diversion ditches will have to be hand-dug to minimize damage to the alpine vegetation. Alkaline amendments should also be added to the vegetation kill zones, then the area should be seeded and mulched.

The shafts and stopes at the Ben Butler mine should be backfilled if possible. The mine waste rock should be amended with fly ash and cement, then used to backfill the mine openings. If the shafts and stopes cannot be backfilled completely, lime, or limestone should be placed in the shaft and water filled stopes to provide some buffering capacity.

Prairie Mine Site

Location
This site is located on the north side of Burrows Creek approximately 500 feet east of the London Mine. The mine is located at an elevation of 11,920 feet. This site is believed to be on the Prairie patented mining claim. This site was sampled as water quality stations DM-8 (Figures 3 & 4). The waste rock was not sampled. Stream stations BG-2 and BG-3 bracket the mine site. The main access road into Burrows Creek passes through the site. The site is located at LAT. N37°56'56.5", LONG. W107°34'53.7".

Geology and Mine Workings
A short crosscut adit was driven north into the hillside to intersect the Broad Gauge vein. The Broad Gauge strikes N 45° E. dipping from 50° to 70° SE. The vein is in Burns Formation dacite, but ends abruptly at the contact of the younger intrusive rhyolite body in the drainage gully west of Denver Hill.

Mine Wastes
The waste rock was not sampled at this site. The waste rock is generally coarse, with manganese staining. The waste rock pile contains approximately 600 cubic yards of material.

Historic Structures
There are no historic structures on this site.

Geologic Constraints to Reclamation
There are no specific geologic hazards affecting the site. It is beyond avalanche runout zones from Houghton Mountain, and is situated on relatively gently, rocky slopes. Access is good. A relatively thick deposit of loose scree and alluvial debris is adjacent to the site at the mouth of the small drainage on the west side of Denver Hill. This mixed talus and debris deposit might be amendable to provide covering materials.

Water Quality Impacts
The drainage from this mine is relatively clean. Measured flow rates varied between 0.5 and 2.5 gpm. The pH of the adit discharge was near neutral. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.01-0.02% of the dissolved heavy metals. Compared to the groundwater inflow loading that occurs in the stream segment containing this mine, the adit discharge is an insignificant source of metals.

Heavy metals loading from the Prairie Mine are given below.

Prairie Mine DM-8

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low -Flow	BDL	BDL	0.01	BDL	0.01	BDL	0.21	2.32
High-Flow	BDL	BDL	0.0	BDL	BDL	BDL	0.1	6.6

Reclamation Options
No reclamation is currently recommended for this site. The adit discharge is thought to be an insignificant source of metals to Burrows Creek. The waste rock also does not appear to be a significant source of metals

Red Cloud and Boston Mine Complex

Location
This site is located on the north side of Burrows Creek along the northwest side of Houghton Mountain above the trans-basin diversion ditch. There are four capped shafts and one collapsed adit at this site. The shafts are located adjacent to the access road through upper Burrows Creek. Elevations range from 12,020 feet to 12,240 feet. The collar of the main shaft is at an elevation of 12,110 feet. The workings are situated on the Boston, Dewitt, Burrows No.2, Red Cloud, and Deposite patented claims. Sample sites include waste rock sites #21, the Boston mine shaft, and #22, the Red Cloud mine shaft (Figure 4). The Boston Shaft is located at LAT. N37°56'49.5", LONG. W107°35'21.5". The Red Cloud Shaft is located at LAT. N37°56'38.5", LONG. W107°35'32.3"

Geology and Mine Workings
There are four shafts and an adit, with associated mine dumps, at this site (Figure 22). Waste rock sampling site #22 is the dump at the main shaft. Workings on the Red Cloud are the most extensive of any of the mines in the Animas Headwaters-Burrows Creek area. The mine developed a strongly mineralized vein system, which continues its northeast-ward course in the Burns Formation beneath Burrows Creek, where it becomes the Ben Butler vein described above. Interestingly, Burrows Creek is shown on 1935 base maps as disappearing into the ground in the vicinity of the vein system near the bottom of the slope of Houghton Mountain.

The Boston mine is 650 feet northeast of the Red Cloud main shaft on the same vein structure. It consists of a tunnel 200 feet long driven S. 45° W. on the vein, which dips 70° SE. A shaft was sunk later on the dump, its collar only 5 feet higher than the adit. The vein is a stringer lode along sheeting in rhyolite flows (Kelly, 1946).

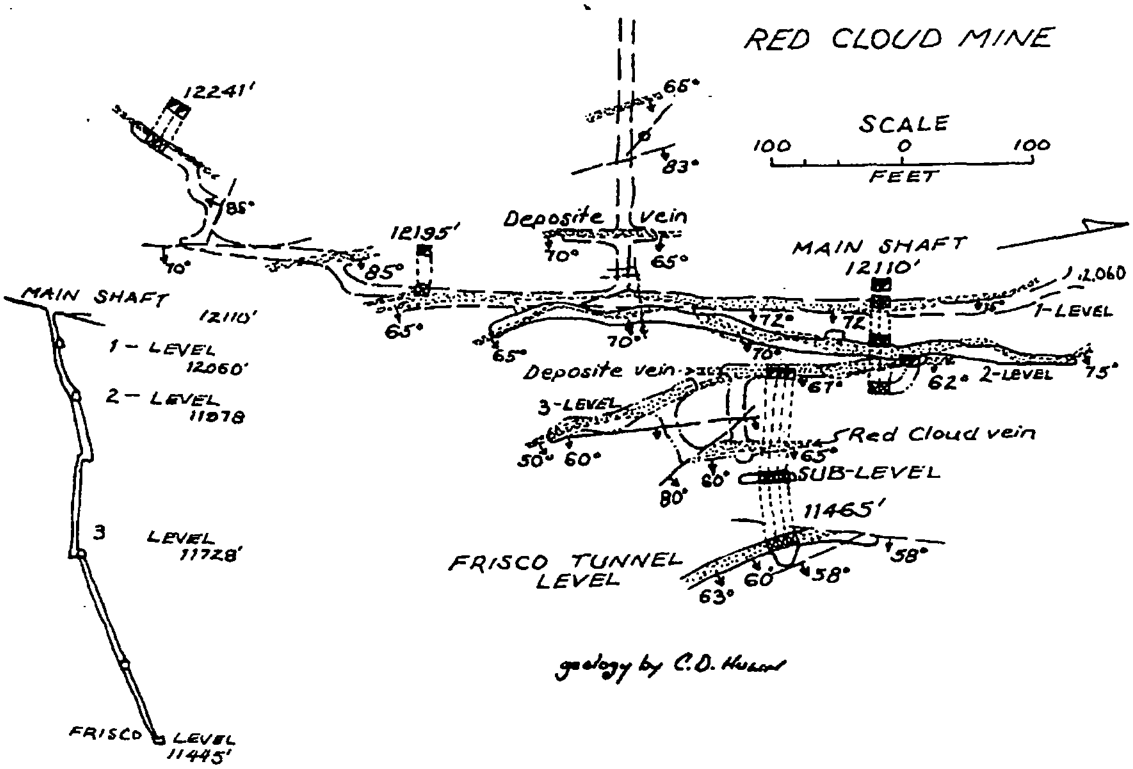


Figure 22. Red Cloud and Boston Mine Complex

The Red Cloud mine was investigated by V.C. Kelly in 1945. (Kelly, 1946). He reports:

> *The Red Cloud Mine is probably the most worked if not most productive property in the area. It comprises 3 levels containing 2,000 feet of drifts, crosscuts, and raises. Three shafts have been sunk: a main or lower one at an altitude of 12,110 feet, one at 12,195 feet, and one on a westward branch of the vein at 12,241 feet. An adit whose portal lies northeast of the main shaft connects with all three of these shafts on what is known as the No. 1 level. The portal is caved and none of*

the shafts can be entered from the surface, or from the Red Cloud drift on the Frisco (Bagley) Tunnel level. The Frisco level, 665 feet below the collar of the main shaft, is connected by a raise to the Red Cloud No. 3 level, which is 282 feet below the main shaft collar. The strike of the Red Cloud vein at the main shaft is N. 50° E and dip is 70° SE. This vein is one of a multiple set forming a zone about 500 feet wide. It is the middle of three prominent outcropping veins of the set, which converge northeastward on the Dewitt claim. About 250 feet southwest of the main shaft, the western Deposite vein converges with and probably crosses the Red Cloud vein to join the eastern Vermillion Extension vein farther south. The upper shaft and the southwestern end of the No. 1 level drift appear to be on a prominent westerly branch that may be the Dakota vein. The intervening ground between these three principal veins is laced by many smaller veins, some of which widen considerably in places. The entire 500 foot-wide zone may be considered as a wide stringer lode. Some mineralized stingers change abruptly into dense white quartz ribs as much as 12 or 15 feet wide. The country rock is strongly banded rhyolite and Burns Formation dacite and rhyodacite flows. Locally the quartz veins are filled with the brecciated fragments of altered wall rock, and black pyrolusite stains the weathered surfaces of many breccia fragments. Between 1874 and 1891, 800 tons of gray copper and galena ore are claimed to have been taken from the mine. Output since 1900 has been small, and is incorporated in the output of the Frisco Tunnel. The Red Cloud workings were opened up for sampling and examination by the Sunnyside Mining and Milling Co. in 1928-1930. In 1914 the Red Cloud Leasing Co. shipped 23 tons of lead and dry siliceous ores which contained 4.80 oz. gold, 426 oz. sliver, 117 lbs. copper, and 6,639 lbs. Of lead.

Mine Wastes
In all, there is roughly 4,000 cubic yards of waste rock at this mine complex. The waste rock pile at sampling site #21 contains approximately 900 cubic yards of waste rock, while the waste rock pile at sampling site #22 contains approximately 600 cubic yards of waste rock. The waste rock at both sites is similar except that the waste at site #21 is considerably coarser. The waste rock at this site is a yellowish coarse to fine-quartz- sulfide waste. At the main shaft dump, considerable sphalerite and some galena ore are present. Solid pyrite masses and pyritic gray quartz gangue is common. Sphalerite is both fine-and coarse grained, much of it speckled in quartz with pyrite. Rhodonite and rhodochrosite were found on the middle shaft dump in both wall rock and vein matter, with base metals much less common. Pyrite seams, some with radial structure, are also present. The waste piles, in general, have high concentrations of iron, lead and zinc. There are vegetation kill zones below all the waste rock piles in this area.

Selected results from the waste rock leachate analysis are given below.

Boston Mine Site #21

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.65	26	88	4	32	230	120	100	710

Red Cloud Mine Site #22

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.27	49	440	41	170	1100	110	4300	7500

Historic Structures
There is a shafthouse and compressor at the second shaft from the top.

Geologic Constraints to Reclamation
There are no specific geologic hazards affecting the site. It is beyond avalanche runout zones from Houghton Mountain, and is situated on relatively gentle, rocky slopes. There is nothing available in the way of unconsolidated materials for excavation or covering work. The fissured ground is somewhat permeable, and infiltration is rapid.

Water Quality Impacts
Presently there are no direct surface water quality impacts from this site. In 1997, the trans-basin diversion ditch was partially breached, and most of the flow from the upper Burrows Creek watershed was flowing to the Animas River. In 1998, the trans-basin diversion had been repaired, and all the water was flowing to Mineral Creek.

This mine site may be a partial source of the adit discharge from the Bagley Tunnel. There is a documented connection to the workings.

Reclamation Options
If the trans-basin diversion is maintained, reclamation of the waste rock piles at this site will have no effect on the water quality of the Animas River. If, however, the trans-basin diversion is breached in the future, the waste piles should be reclaimed. Reclamation should involve construction of diversion ditches around the waste piles, revegetation of the kill zones below the piles, and lime or limestone should be added to the waste rock piles.

Part of the adit discharge from the Bagley Tunnel may come from mine workings on the Red Cloud vein. A tracer should be added to the mine shafts to determine what proportion of the Bagley adit discharge comes from this area. If the tracer shows that a significant metals load is generated in these workings and being released in the Bagley discharge, lime or limestone can be added to the shafts to precipitate metals inside the mine and prevent dissolution of some metals. It might also be feasible to drill down through the caved debris in the shafts, and inject a neutralizing, lime/ fly-ash slurry into the workings from the bottom to the tops of the shafts. This big slug of buffering capacity may help to curtail acid production and metals loading in the abandoned workings, and possibly reduce groundwater inflows into the workings by sealing fractures and backfilling stopes.

Unknown Prospect in Lower Burrows Creek

Location
This site is located on the south side of Burrows Creek on the northeast flank of Houghton Mountain. The mine is located at an elevation of 11,800 feet. This site is believed to be on the Denver patented mining claim. This site was sampled as water quality stations DM-31 and waste rock sampling site #17(Figures 3 & 4). Stream stations BG-4 and BG-5 bracket the mine site. The adit is located adjacent to the stream on the south side immediately before Burrows Creek cascades into the Upper Animas River. The site is located at LAT. N37°56'45.8", LONG. W107°34'33.8".

Workings
A small adit was driven southwest into the flanks of Houghton Mountain along a fault zone. There are numerous other prospects located along this fault. This site is the lowest and the largest of the prospect adits.

Mine Wastes
The waste rock pile extends into the stream. The waste rock is generally fine to coarse textured with small amounts of pyrite, sphalerite and galena in a quartz and fault gouge matrix. The waste rock pile contains approximately 150-200 cubic yard of material. There are numerous small prospects along and adjacent to the same fault. The results of the leachate analysis are presented below.

Unknown Mine in Lower Burrows Creek

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
4.64	22	70	BDL	2	260	12	57	69

Historic Structures
There are no historic structures on this site.

Water Quality Impacts
The drainage from this mine is relatively clean. The flow measured during low-flow, was approximately 1 gpm with a pH of 5.9. There was no flow from the adit in July 1998. There was considerable ice inside the adit that may be the source of flow later in the year. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.01% of the heavy metals during low-flow.

Heavy metals loading from this mine are given below.

Unknown Mine in Lower Burrows Creek

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low–Flow	BDL	BDL	0.01	0.03	0.19	0.02	0.62	2.26

Reclamation Options
No reclamation is currently recommended for this site. The adit discharge is thought to be an insignificant source of metals to Burrows Creek. The waste rock also does not appear to be a significant source of metals. The waste rock could be used as a capping material for other mines in the vicinity.

CALIFORNIA GULCH

Location

The headwaters of California Gulch begin near California Pass approximately 3 miles west of Animas Forks. California Gulch joins the Animas River at Animas Forks. The elevation range in the California Gulch watershed is 13,447 feet in the headwaters at Hurricane Peak to 11,150 feet at its confluence with the Animas River. Placer Gulch joins with California Gulch approximately 1 mile west of Animas Forks. Mine sites in this area selected by DMG and ARSG for reclamation feasibility studies include the Mountain Queen, Ida, Burrows, Vermillion,

Vermillion Tunnel, Bagley Tunnel, and Columbus. These sites are shown on Figures 3 and 4. The mines are situated on privately owned patented mining claims. Coordinates of each site are given in the individual site descriptions, which follow below.

This area is characterized by a broad glaciated valley with the majority of the watershed above timberline. Winters are long with snow depths averaging 440 inches, and the summer growing season is short. Average total precipitation for the past 3 years is 45 inches, 37 inches occurring as snowfall (SGC data).

Geologic Setting

Burns Formation dacite and rhyodacite volcanic flow rocks outcrop in the upper part of the California Gulch watershed. Moving down valley, the older underlying Eureka Tuff outcrops in the floor and valley walls on down to Animas Forks. The contact between these two rock units is traceable on surface, where it climbs from 11,880 feet in the creek bottom up the north valley wall to the upper south shoulder of Houghton Mountain.

A long dike of younger intrusive quartz latite porphyry runs along the north valley wall of the gulch from the south summit of Tuttle Mountain to the southeast shoulder of Houghton Mountain. This younger dike follows a fracture system that offsets the Burns-Eureka contact along the floor of California Gulch. The dike joins with the larger intrusive porphyry mass forming the southeast shoulder of Houghton Mountain near the upper Columbus mine workings.

The younger intrusive porphyry body on Houghton Mountain has fractured and partly altered the country rock enclosing it. A prominent, broad zone of northwest trending mineralized fractures extends through the porphyry intrusive into the surrounding Burns and Eureka Tuff formations, probably reflecting the trend of the underlying ring-fault system here. This zone of deep-seated faulting was a favorable site for solfataric hydrothermal alteration processes. Burns formation rocks capping the summit of Houghton Mountain are solfatarically altered, weathering to bright orange and red talus deposits, as is common in the Red Mountain district farther west.

California Gulch lies on the northern margin of the Silverton Caldera, in a complex zone of fissure veins (Figure 2). There are roughly three vein sets: a dominant set of major northeast-striking fissures which run parallel to the northern margin of the Eureka graben throughout the area; a second set of dominant almost east-west trending fissures at the extreme head of the gulch near the Mountain Queen Mine; a third north-northwest trending minor vein set in the Houghton Mountain-Animas Forks area near the Columbus Mine (Burbank and Luedke, 1969). This latter set may reflect the underlying ring-fault system on this margin of the caldera, which runs through the Animas Forks area.

Prominently visible silicified fissure veins of the first vein set crop out on the north valley wall of California Gulch. These veins are characterized by hard resistant white quartz ribs that can be traced through the saddle between Houghton and Tuttle Mountains, where they continue into the Burrows Creek watershed. The veins are vertical or steeply southeast dipping, with normal sense of movement downward toward the southeast. This principal vein system was the focus for prospecting and mining in California Gulch.

Surficial Geology

Upper California Gulch is mantled with extensive unconsolidated surficial deposits. A large rock glacier spills down the steep slopes into the valley between Hurricane Peak and California Mountain. Extensive talus deposits cover the lower footslopes and southeast valley walls below

California Mountain, and glacial and alluvial gravels and debris cover the valley floor near the head of the gulch. Talus and glacial deposits also cover much of the valley floor and the north slopes of Treasure Mountain near the Bagley Tunnel and Animas forks.

California Gulch Site Descriptions

Mountain Queen Mine

Location

The Mountain Queen Mine is situated in the headwaters of California Gulch. The Mountain Queen consists of a shaft near the top of California Pass at an elevation of 12,790 feet and a draining mine adit east of the shaft at an elevation of 12,375 feet. This site is believed to be on the Mountain Queen, Eclipse, Agitator, Fairchild, and Animas Belle patented mining claim. The draining adit was sampled as water quality station DM-10 and as waste rock site #2 (Figures 3 & 4). The shaft site was sampled as waste rock site #1 (Figure 4). Stream stations CG-1 and CG-2 bracket the mine site. The shaft site is located at LAT. N37°54'53.9", LONG. W107°37'01.8". The adit site is located at LAT. N37°55'00.5", LONG. W107°36'45.2".

Geology and Mine Workings

The Mountain Queen is one of the oldest mines in the district. It developed the Mountain Queen vein on the east side of Hurricane Peak. The vein was opened by a shaft 400 feet deep, and was worked intermittently from the 1870's to the 1950's. In 1877, its ore was shipped by pack train to the Crooke and Co. smelter at Lake City via Engineer Pass (Burbank and Luedke, 1969). The deposit was examined by the U.S. Bureau of Mines in the late 1940's. In Report of Investigation 4508, S. W. Hazen states:

> *The Mountain Queen Vein strikes N. 45° E on the west end of the claim, turning almost directly east at the shaft. Branches of the vein outcrop as a number of quartz ribs with altered siliceous areas between. The vein material is predominantly quartz with bands and stringers of pyrite. Many pits, cuts, trenches and shallow shafts were opened on the vein, all exposing pyrite either in quartz or in a siliceous gangue between the quartz ribs. The 400-foot deep shaft was sunk on a lead ore shoot. An adit started in the bottom of California Gulch was driven 1,500 feet toward the shaft, but the raise driven from the end of the adit failed to connect with the shaft. The shaft is now caved and inaccessible below the 70-foot level, which was being worked by lessees in 1946. The access road recommended by the Bureau of Mines was constructed in 1944. Stopes above the north drift on the 70-foot level holed to surface and are now partly caved. Workings on a parallel ore shoot south of the shaft are also caved. The ore being worked in 1946 on the 70-foot level averaged from 4 to 5 feet in thickness. From 1900 through 1946 the mine yielded 3,500 tons or ore from which were recovered 82.16 oz. gold, 26,663 oz. silver, 25,401 lbs. copper, 531,931 lbs. lead, and 278,339 lbs. zinc. A shaft on a northeast-striking vein north of the main shaft was sunk on a narrow lead ore shoot, and one about 100 feet farther east on the same ore shoot. Most cuts and pits expose only quartz with pyrite stringers.*

Mine Wastes

Ten waste rock samples were taken and composited at the shaft site. Fourteen samples were taken and composited at the larger waste rock dump located at the draining adit. The waste rock at this site is mostly coarse, with a lot of quartz and inter-grown pyrite. Some areas of coarse to fine-quartz- sulfide waste are also present. Black manganese staining on the waste rock is prevalent. Some good lead-zinc ore can still be found on the dump at the shaft. The adit dump in California Gulch is mostly gray barren quartz and pyrite, with coarse to fine grained components. Drainage from the adit splits and flows off either side of the dump almost immediately (Figure 23). There is a lot of natural hematite-stained talus and scree mantling both sides of the outcropping quartz vein, from the main shaft area to the bottom of the outcrop in California Gulch.

The waste rock pile at the shaft is situated adjacent to the 4-wheel drive access road over California Pass. The site is commonly covered with deep snowpack through mid- to late-June. At the adit site, snow commonly drifts around the waste pile, with a lesser amount on the top of the waste rock. The adit is commonly covered with snow through mid-July. The waste pile at the shaft site is estimated to contain 1,900 cubic yards. The waste pile at the adit site is estimated to contain 3,200 cubic yards.

The results of the waste rock leachate analysis are given below.

Mountain Queen Mine Site #1

pH s.u.	Total Acidity mg/l	Al Ppb	Cd ppb	Cu ppb	Fe Ppb	Mn ppb	Pb ppb	Zn ppb
3.73	57	220	20	280	2300	64	6500	3300

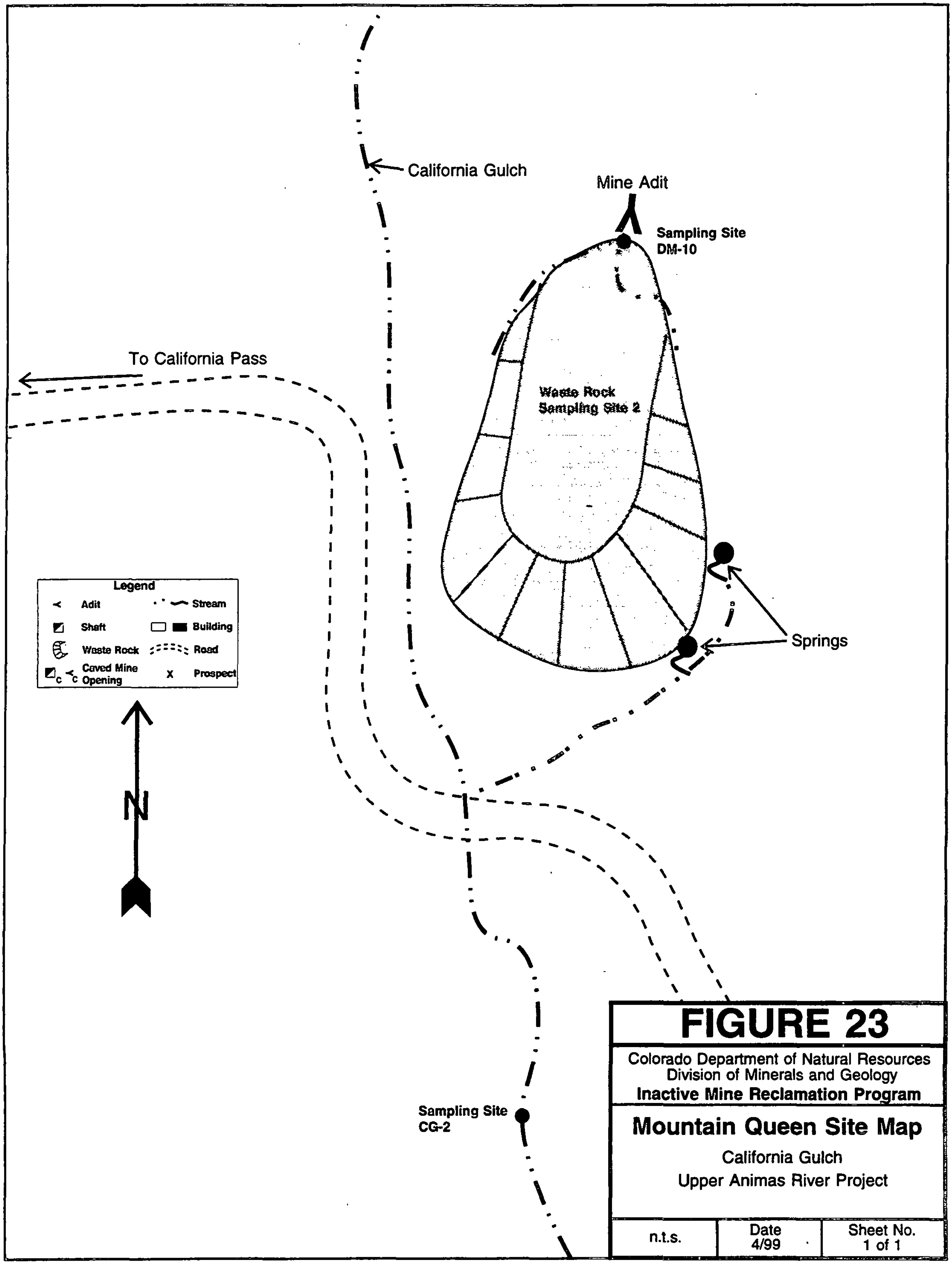
Mountain Queen Mine Site #2

pH s.u.	Total Acidity mg/l	Al Ppb	Cd ppb	Cu ppb	Fe Ppb	Mn ppb	Pb ppb	Zn ppb
3.63	144	280	28	390	230	460	2000	5100

Historic Structures
At the Mountain Queen shaft, there are the remains of several structures on the ground plus a steam boiler. There are no historic artifacts at the adit site except for scattered debris.

Geologic Constraints to Reclamation
Minor rock-fall and potential snow avalanches from the steep slopes of Hurricane Peak affect the site. Bedrock outcrop covers the entire area, so there is little potential for excavation or cover materials onsite, however, there are significant unconsolidated deposits nearby. The elevation and northeast aspect mean snow pack is on the ground until mid July.

Water Quality Impacts
There is a water quality impact from the Mountain Queen shaft site associated with leaching of the waste pile. Because of the high elevation of this site, leaching is limited to the summer months. Leaching of the waste pile may account for a portion of the load measured at water quality station CG-1. Overall, the impacts from this site are believed to be small.


California Gulch
Mine Adit
Sampling Site
DM-10
To California Pass
Waste Rock
Sampling Site 2
Springs
Legend
Adit
Stream
Shaft
Building
Waste Rock
Road
Caved Mine
Opening
Prospect
N
Sampling Site
CG-2
FIGURE 23
Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program
Mountain Queen Site Map
California Gulch
Upper Animas River Project
n.t.s.
Date
4/99
Sheet No.
1 of 1

Water quality impacts from the adit site come from both the adit discharge and leaching of the waste rock by the adit discharge, and precipitation. Details of the adit site are shown in Figure 24. The flow from the adit has been measured between 2.5 and 13 gpm, with a pH of 3.7 to 3.9. There is a small vegetation kill zone below the waste rock pile, and iron staining along a short flow path below the pile. No flow has been observed below the pile, so this is believed to occur during snowmelt when there is still a snow cover on the area surrounding the pile. Although the waste rock is not highly acidic, there is some heat generated by acid production as evidenced by the earlier melting of the snow on the pile than the surrounding area. Outside the mine adit, there is a build-up of iron precipitate. The build-up may be from suspended iron carried by the adit discharge. It has been observed that there are shallow groundwater inflows near the mouth of the adit that could aid in precipitation of iron.

Figure 24. Mountain Queen Mine Adit

The Mountain Queen adit produces approximately ¾ pounds of metals per day during low-flow and approximately 1 pound of metals per day during high-flow. As the adit discharge passes through the mine waste pile, it may leach additional metals from the waste rock. The adit discharge can only account for a portion of the metals found at station CG-2, downstream of the site. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.94-1.5% of the dissolved heavy metals, but produced about 10 to 11% of the dissolved copper. The measured metal loadings from this mine are given below.

Mountain Queen Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	49.29	0.04	0.76	27.68	111.15	1.66	50.07	79.06
High-Flow	110.3	BDL	1.2	42.9	159.0	3.9	96.2	122.7

Reclamation Options
Reclamation should be done at the draining adit site for both the adit discharge and the waste rock pile. It is recommended that an anoxic limestone drain be constructed in the adit, and a small settling pond should be constructed outside the adit. If the settling pond is constructed on the waste pile, it should be lined to prevent leaching of the waste rock. There is sufficient room to construct a small pond on the south side of the waste rock pile. Because of the high elevation, there are few methods of treatment available for this site. The mine workings should be investigated to determine the characteristics of the inflows. Based on this assessment, the feasibility of grouting, internal diversion, or sealing the inflows can be determined. Based upon the jointing of the rock in the area, it is probable that there may be too many individual inflows for grouting to be cost-effective, however, this should be checked.

The waste rock pile should either be injected with a lime/fly ash mixture, or receive a surficial coating of ground limestone. This will provide some buffering action to reduce the amount of acid production in the pile. Because of the visibility of this site to tourists, injection of a lime/fly ash mixture is recommended.

Indian Chief Mine

Location
This site is located near the headwaters of California Gulch approximately 300 yards downstream from the Mountain Queen Mine at an elevation of 12,290 feet. This site is believed to be on the Extension patented mining claim. This site was sampled as water quality station DM-28 and as waste rock site #3 (Figures 3 & 4). Stream stations CG-2 and CG-3 bracket the mine site. The site is located at LAT. N37°55'10.8", LONG. W107°36'47.2".

Geology and Mine Workings
An open, flooded adit drifts west for several hundred feet on the Indian Chief vein. This 7 to 8 foot wide quartz-pyrite vein has a lead ore shoot 12 to 18 inches wide along the north footwall side of the vein. The Indian Chief vein belongs to the east-west striking group of veins that extend from Poughkeepsie Gulch and Lake Como into California Gulch. The structure continues across California Gulch beneath glacial and talus deposits, cropping out again on the upper slopes of California Mountain as the Custer vein. Dip at the adit portal is nearly vertical.

The vein is characterized by massive bands of solid pyrite in vuggy, white "bull quartz", with large pockets of limonite and pyrolusite. Country rock adjacent to the vein is altered, and pyritized in places. Heavy black manganese staining is prevalent on the vein outcrop. Ferricrete-cemented talus and scree caps the vein outcrop at the portal.

Talus and sloughage at the portal has caused ponding in the adit, damming the water to over 2 ½ feet deep. Water was also flowing directly out of fissures and pockets in the bull quartz zone of the vein in August. Water drains from the adit into a small pond on the dump, which discharges into the dump materials. A second lower adit on the same vein is collapse at the portal.

Mine Wastes
This small waste pile contains approximately 400 cubic yards of waste. Minerals found in the waste rock were principally rhodonite and pyrite. The drainage from the adit ponds on the waste rock, then flows through the pile. There is a small kill zone below this pile and below the

prospect adit below. The waste rock leachate analysis, shows that the waste rock is high in leachable zinc and manganese. The results of the leachate analysis are given below.

Indian Chief Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
5.13	2	210	49	46	63	6900	BDL	6400

Historic Structures
There are no structures or equipment, other than scattered debris.

Geologic Constraints to Reclamation
There are no specific geologic hazards affecting the site other than potential snow avalanches form the slope above the site. A relatively thick deposit of loose scree and alluvial debris is adjacent to the site near the base of the valley wall along California Gulch. This mixed talus and debris deposit might be amendable to provide covering materials.

Water Quality Impacts
Water quality impacts from this site are principally from the adit discharge passing through the waste rock. The adit discharge is an insignificant source of metals to California Gulch. The flow from the mine adit varies from 2 to 42 gpm. The pH of the drainage ranged from 5.9 to 6.8. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.03-0.06% of the dissolved heavy metals. This adit discharge produced about 2 to 8% of the dissolved aluminum load from the adit discharges in the Upper Animas River. The measured metal loadings from this mine are given below.

Indian Chief Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	BDL	0.06	0.01	BDL	0.12	0.22	5.90	2.17
High-Flow	BDL	BDL	BDL	BDL	2.2	BDL	13.7	5.3

Reclamation Options
The only reclamation recommended for this site is to divert the adit discharge away from the waste rock pile, and revegetate the denuded area below the pile. This mine apparently has a minor effect on the water quality of the California Gulch.

Little Ida Mine

Location
This site is located on the north side of California Gulch. There are 4 draining adits and several prospects at this site. The adits range in elevation from approximately 12,400 feet to 12,200 feet. This site is believed to be on the Little Ida and Equator patented mining claims. This site was sampled as water quality stations DM-11, DM-12, DM-13, and DM-14 and as waste rock sites #4 and #5 (Figures 3, 4 & 25). The site is located at LAT. N37°55'57.6", LONG. W107°36'15.3" (taken midway between the two lower adits).

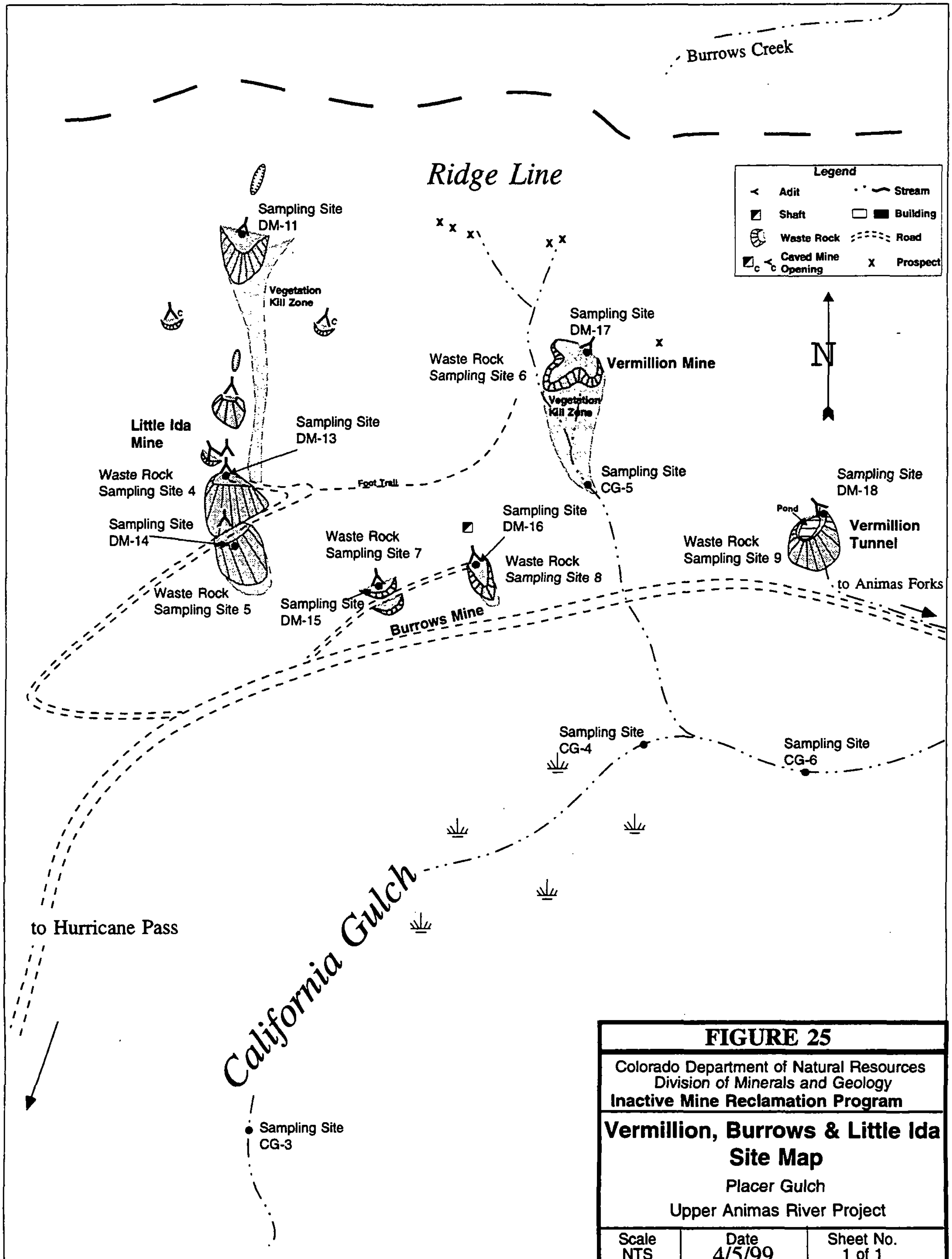


FIGURE 25

Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program

Vermillion, Burrows & Little Ida Site Map

Placer Gulch

Upper Animas River Project

Scale	Date	Sheet No.
NTS	4/5/99	1 of 1

Geology and Mine Workings

Early work was done through adits between 12,700 and 12,500 feet elevation on the Little Ida, Parallel, and Equator veins on the upper slopes. Lenses and shoots of silver-lead ore were mined from these veins. A series of less persistent north- northwest trending veins including the Little Ida run straight up the side of the gulch in this area, and the best ore bodies seemed to occur where these veins intersected with the dominant northeast trending Parallel, Equator, and Vermillion Extension veins (Burbank and Luedke, 1969). The ore was found in bunches and lenses at these intersections, but apparently did not persist in economic grade very far along either vein set, necessitating lots of short adits to mine the accessible vein intersections.

A newer operation started in 1947 lower at the 12,000-foot level (DM-14). A crosscut was driven northwest to intersect the Little Ida and other veins at depth, the intent being to open up a good vertical section of ore. About 1,000 tons were mined from the Burrows and Little Ida group after 1947. Ore is reported to have run about 16% zinc, 10% lead and 3 oz. silver to the ton (King and Allsman, 1959)

Mine Wastes

Sample sites 4 and 5 were composited because the waste piles are contiguous (Figures 4 & 25). Each pile was sampled in 6 places and composited. The waste rock piles are steep sided, containing an aggregate of approximately 1,100 cubic yards of fine to coarse waste. There are vegetation stress zones below all the waste piles. The waste rock at this site is varied. Many dumps are composed of a wide mixture of both country rock and fine to coarse-grained pyritic quartz and siliceous gangue materials. Several small hand-cobbed stock piles of high grade lead-silver ore were found on two of the dumps high up on the steep valley wall where tourists don't often reach. There is a lot of bull quartz and massive inter-grown quartz-pyrite boulders and cobble-sized materials at the toes of the outslopes of most of the larger dumps. Some areas of fine clayey gray quartz-sulfide waste are also present in most dumps. There is a large vegetation kill zone below the waste pile at adit DM-11 (Figure 25). The waste piles at water quality sampling sites DM-13 and DM-14 are larger than those above. Because of the steep hillside, all the mine dumps cover a large area. Selected results from the leachate analysis are given below.

Little Ida Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.64	55	1800	26	620	1500	1400	12000	6100

Historic Structures

There are no structures or equipment, other than scattered debris. The lower adit still has rails leading from the portal. Stulls and short timber collars remain in some of the shallow stope workings.

Geologic Constraints to Reclamation

There is some potential for snow avalanches from the steep slopes of Tuttle Mountain above the site. Access to the upper adits would have to be constructed, as these are currently accessible only on foot or ATV. Bedrock outcrop covers the entire area, so there is little potential for excavation or cover materials onsite.

Water Quality Impacts
Water quality impacts from this site are principally from the adit discharges. As the mine drainage passes through the mine waste pile, it is likely that additional metals are leached. Based upon the leachate analyses, it is likely that some zinc is leached from the waste rock.

During low-flow, the adits at sampling sites DM-11, DM-12 and DM-13 are dry. During the high-flow sampling, the flow at station DM-11 was approximately 15 gpm. During high-flow, adit DM-12 was seeping, but no flow could be measured. During high-flow, the flow at adit DM-13 was 2 gpm. The flow from adit DM-14 varied between 2 and 2.5 gpm. The drainage from DM-14 exits the adit through a steel pipe under the access road. The pH of the adit discharges ranges from 5.9 to 7.2.

The adit discharges from this site appear to be an insignificant source of heavy metals. In aggregate, the adit discharges produce less than 0.25 pounds of heavy metals per day during high-flow, and less than 0.05 pounds per day during low-flow. The major metal from this mine is zinc. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.03-0.33% of the dissolved heavy metals.

Little Ida Mine DM-11

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	No Flow							
High-Flow	BDL	BDL	0.3	0.9	7.8	24.8	0.7	36.0

Little Ida Mine DM-13

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	No Flow							
High-Flow	0.7	BDL	0.0	0.2	BDL	1.3	0.6	3.1

Little Ida Mine DM-14

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	0.95	BDL	0.04	0.25	0.15	0.35	1.35	7.59
High-Flow	7.4	BDL	0.1	1.6	0.4	2.6	3.0	24.3

Reclamation Options
The only reclamation recommended for this site is to divert the adit discharges away from the waste rock piles and construct diversion ditches around the waste piles. The adit discharge should be diverted by constructing a bulkhead seal in the adits to collect the water, then pipe the mine drainage outside the adit. Since there is very little iron in the adit discharge, plugging of the pipe by sludge should not be a problem. Even though there is presently a pipe conveying the adit discharge away from adit DM-14, a new pipe should be installed along with a bulkhead seal to make certain that most of the mine drainage is captured. There may be some mine drainage flowing through the unconsolidated material creating the dam inside the adit. Piping and bulkhead sealing will also help to determine whether any future reclamation is needed.

Burrows Mine

Location
This site is located on the north side of California Gulch, north of the main 4-wheel drive road, approximately 1.5 miles west of Animas Forks. The site is located down-slope and slightly east of the Ida Mine discussed above. There is an overgrown access road leading to this site. The two adits at the site are at an elevation of approximately 12,040 feet. This site is believed to be on the Burrows claim. This site was sampled as water quality stations DM-15 and DM-16 and as waste rock sites #7 and #8 (Figures 3, 4 & 25). Stream stations CG-3 and CG-4 bracket this mining site. The DM-7 site is located at LAT. N37°55'52.5", LONG. W107°36'14.6". The DM-8 site is located at LAT. N37°55'53.9", LONG. W107°36'04.5".

Workings
Two open draining adits are driven north into the valley wall. The adits are believed to be crosscuts to access the northeast trending Equator Vein. The easternmost adit connects with an open stope approximately 250 feet beyond the entrance.

Mine Wastes
Mine waste was sampled at the two adit discharges at this site. The waste rock in the westernmost mine waste pile (site #7) is characterized by pyrite, sphalerite, and some galena and rhodonite in a quartz gangue. The waste rock is generally coarse. Ten samples were taken from this waste pile. The waste piles contain approximately 750 cubic yards of material. The top portion of the waste pile is vegetated and consists of mixed colluvium and mine waste.

The easternmost mine waste pile (site #8) is similar in mineralogy, but generally contains finer material. There is very little galena on this site. The waste pile is white to light yellow with country rock and fine to coarse-grained pyritic quartz and siliceous gangue. There is a small vegetation kill zone below the waste rock pile. This waste pile contains approximately 1,750 cubic yards. A waste rock pile above site #8 on the same vein contains approximately 900 cubic yards.

The waste rock in both piles has a high zinc content. The adit discharge at both sites flows into the waste rock, and infiltrates through the piles into the ground water system. Selected results from the leachate testing are presented below.

Burrows Mine Site #7

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.09	55	610	22	300	1200	1700	1500	5100

Burrows Mine Site #8

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.23	48	280	33	180	590	400	5000	7600

Historic Structures
There are no structures or equipment, other than scattered debris. Rails still lead from the easternmost adit.

Geologic Constraints to Reclamation

There is some potential for snow avalanches from the steep slopes of Tuttle Mountain above the site. Bedrock outcrop covers most of the area, so there is little potential for excavation or cover materials on-site.

Water Quality Impacts

Water quality impacts from this site are from the adit discharges and leaching of the waste rock. The flow from the western adit (water quality sampling site DM-15) measured between 1 and 2.5 gpm with a pH of 4.7 to 5.7. The flow from the eastern adit (water quality sampling site DM-16) measured between 1.5 and 2.5 gpm with a pH of 4.9 to 5.4.

The adit discharges produce approximately 0.2 to 0.4 pounds of dissolved metals per day. Approximately 90% of that amount is zinc. Based upon the mine waste leachate analyses, it is likely that additional zinc is leached from the waste rock as the mine drainage passes through the pile. Also, it is believed that there is some mine drainage that flows through shallow fracture systems and/or through the material forming a small dam at the adit entrance. The drainage from these adits may be a larger source of zinc than has been measured to date.

Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.27-0.3% of the dissolved metals. The measured metal loadings from this mine are given below.

Burrows Mine DM-15

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	2.4	BDL	0.1	0.3	0.0	2.6	4.2	27.9
High-Flow	5.6	BDL	0.3	0.8	0.1	9.0	5.1	47.3

Burrows Mine DM-16

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	0.2	BDL	0.2	0.1	BDL	BDL	2.6	50.9
High-Flow	1.3	BDL	0.4	0.3	0.6	0.1	6.9	103.8

Reclamation Options

Although this mine site appears to be a minor source of metals, there may be a larger dissolved metals load than was measured. The adit discharges should be collected by constructing a bulkhead seal or partial bulkhead inside the adit to determine the actual amount of flow from these adits. At a minimum, the adit discharge should be diverted away from the waste rock piles, and diversion ditches should be constructed around the waste rock piles. The adit discharge can be partially treated by constructing an oxic limestone drain. It has been shown that zinc will sorb to limestone, and since there is very little iron or aluminum in this mine drainage, there should be very little coating of the limestone. The limestone can be placed inside the adit or outside the adit in a trench. It is recommended that the limestone be placed inside the adit, so eroded soil will not fill the voids. The limestone would have to be conveyed into the adit at site DM-15. Some of the limestone would have to be conveyed into site DM-16, but part of it could also be dumped into the open stope above the mine adit.

Vermillion Mine

Location

This site is located in a large gentle swale high on the north side of California Gulch near the southwestern flank of Houghton Mountain (Figure 26). The mine adit is at an elevation of 12,440 feet. This site is believed to be on the Parallel patented mining claim. This site was sampled as water quality station DM-17 and as waste rock site #6 (Figures 3, 4, & 25). Stream stations CG- 4 and CG-6 bracket the small tributary from this site. Stream station CG-5 is located downstream of the mine on the small tributary. The site is located at LAT. N37°56'09.1", LONG. W107°36'00.1".

Geology and Mine Workings

The Vermillion mine operated through a short crosscut adit that intersected a cluster of vein intersections. As in the adjacent Little Ida ground, the best ore shoots seemed to occur where these veins intersected with the dominant northeast trending Parallel, Equator, and Vermillion Extension veins (Burbank and Luedke, 1969). The ore was found in bunches and lenses at these intersections.

Figure 26. Vermillion Mine Site

The adit is still open and has a slight blockage at the portal that has impounded water to a depth of 2 ½ feet in the adit. The adit is driven south of and adjacent to the Parallel vein, but cuts across it just beyond the portal, whereupon the heading swings abruptly to N. 15° W. It continues on this heading for 300 feet, where the Vermillion Extension Vein system is intersected nearly perpendicularly. Extensive drifts both to the north and south have been developed, and some stoping along the north drift has holed through to surface in the saddle west of Houghton Mountain. Only short drifting was done on the Parallel vein near the portal. Cold air blows out the upper portal in summer months.

In 1910, the Vermillion Co. milled 2,736 tons of ore, which yielded 27 oz. gold, 5,250 oz. silver, 1,998 lbs. copper, 217,500 lbs. lead, and 201,873 lbs. zinc (Kelly, 1946).

Mine Wastes
The waste rock is very similar to dumps on the adjacent Little Ida property. Because of the short cross cut to vein material, most of the dump surface consists of fine to coarse-grained pyritic gray-quartz and siliceous gangue materials. There is some bull-quartz and massive inter-grown quartz-pyrite boulders and cobble-sized materials at the toe of the dump outslope. Some indurated areas of fine clayey, gray quartz- sulfide waste, and scattered pieces of high-grade silver-lead ore were also present. Country rock seemed to be near the bottom of the upper part of the pile, as would be expected. The pile is estimated to contain about 5,100 cubic yards.

The waste rock is highly acid forming. Total acidity from the leachate test was the fourth highest found in the Upper Animas watershed. To compound the problem, the waste pile is located in a wetland area immediately below perennial springs. The adit discharge also infiltrates into the waste rock pile. There is a large iron-stained kill zone extending for over 500 feet below the waste pile. White precipitate stains the substrate of this drainage where it enters the kill zone below the dump.

Selected results from the leachate analysis are presented below.

Vermillion Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.99	1207	2300	84	590	7200	1400	2500	18000

Historic Structures
The collapsed walls of a building lie adjacent to the mine entrance and north of the waste rock pile. There are parts of an old ore car and a screw-feed "widow maker"-type machine drill on the dump. Both artifacts are severely rusted by exposure to the adit discharge. Scattered iron and wood debris is also present, and rails still lead out of the portal.

Geologic Constraints to Reclamation
There are no specific geologic hazards affecting the site. Access to the upper Vermillion adit will have to be constructed, as only foot trails remain. There is little available in the way of unconsolidated surficial materials for use as covering materials at the upper site.

Water Quality Impacts
Water quality impacts from this site come from the adit discharge and the waste rock pile. Eight to 34 gpm of pH 3.1 to 3.7 drainage flows from this mine. This adit discharge had the highest zinc concentration of any adit discharge in the study area. The adit discharge produces approximately 7 pound of metals per day during low-flow and over 14 pounds per day during high-flow. Zinc is the dominant metal in the adit discharge, while the dissolved silver and cadmium load from this site was the highest found in the Upper Animas study. Compared to all the adit discharges in the Upper Animas watershed, this adit discharge produced approximately 10 to 17% of the dissolved heavy metals and about 26 to 37% of the dissolved zinc.

The adit discharge passes through the waste rock pile during most of the year, exiting at the toe of the pile near the adit as a spring. The waste rock pile is located in a wetland area below a perennial spring. Some of the water from the spring leaches through the waste rock and exits as a series of springs along the toe of the pile. It is difficult to measure the actual metals load from the mine site because most of the water infiltrates into the coarse colluvium broad swale. By the time the water reaches the relatively steep slopes into California Gulch, it is spread over too wide an area to collect and measure. Measurements taken at low-flow and high-flow indicate a general metal reduction below the mine site, but this is probably due to the inability to measure all the flow. There is a definite reduction in the iron load as evidenced by the prevalent iron precipitate and staining on the rocks in the vegetation kill zone below the mine.

Based upon an assumed 20 inches of precipitation per year, leaching of the mine waste by direct precipitation could produce up to 21 pounds of zinc per year. This amount does not include the perennial leaching of zinc by run-on from the spring above the site.

Most of the increase in metals loading between stream stations CG-4 and CG-6 may be attributable directly to this mine site. There are a few inflows from California Mountain, but the majority of water comes from tributary CG-5. The measured zinc increase in this stream segment varied from 3.2 to 15.7 pounds per day. The measured metal loadings from this mine are given below.

Vermillion Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	120.6	0.8	8.3	51.0	806.7	63.1	285.4	2023.1
High-Flow	159.5	BDL	18.2	81.1	924.3	485.1	565.4	4096.9

Reclamation Options

Reclamation at this site will be difficult. Access into this site is by a foot trail from the road to sampling sites DM-13 and DM-14. To avoid major damage to the alpine ecosystem, reclamation work would have to be supported by pack trains or helicopter. With that in mind, two measures should be taken to reduce the metals loading from the waste rock pile. First, a shallow diversion ditch should be dug to allow drainage from the perennial spring to pass around the waste rock pile. If a deep diversion is dug, it may dry up the wetland above. In order to prevent water from moving through the waste rock, a polyurethane grout curtain should be constructed. Although more expensive than cement grout, the products and the equipment needed to inject the grout are more portable.

Treating the drainage from the mine is more problematic. Constructing an anoxic limestone drain in the adit can reduce heavy metals, but the limestone would be very expensive to get to the site. In addition to importing the limestone to the site, a small settling pond would have to be constructed outside the adit. It may be possible to get a small rubber-tracked loader to the site through Burrows Creek. As an alternative, there are small portable backhoes that can be lifted into the site by helicopter.

It is recommended that the mine workings be investigated to determine whether there are any measures that can be taken to either prevent surface infiltration into the mine, or divert clean inflows out of the mine. These approaches would significantly reduce effluent discharge, and could be the most cost-effective solutions.

Vermillion Tunnel

Location
This site is located on the north side of California Gulch immediately above the California Gulch access road at an elevation of 11,870 feet. The Vermillion Tunnel is located southeast of the Vermillion Mine. This site is believed to be on the Silver or Justice patented mining claims. This site was sampled as water quality station DM-18 and as waste rock site #9 (Figures 3, 4 & 25). Stream stations CG-6 and CG-7 bracket this site. The site is located at LAT. N37°56'02.3", LONG. W107°35'46.4".

Workings
A deeper level crosscut to the Vermillion workings, known as the Vermillion Tunnel, was driven at the 11,870 elevation. This adit was intended to intersect the veins being mined in the upper adit at depth, however, it may not have extended beyond the Burrows vein (Burbank and Luedke, 1969). The Vermillion Tunnel is open and drains up to 120 gpm. The adit heads N. 38° W for at least 800 feet, where it is believed to intersect the Burrows/Two Micks vein.

Mine Wastes
The drainage from this mine exits the adit into a pond on the waste rock pile. There is no spillway on the pond. The adit discharge infiltrates the waste rock and emits as a spring at the base of the pile. The waste rock contains 10,800 cubic yards of fine to coarse country rock mixed with mineralized waste rock. It does have a thin gravelly-sized capping of quartz-sulfide gangue materials, but is dominated by country rock produced from the crosscut. Leachate analysis of the waste rock indicates that it is not a significant source of metals. The waste rock had a similar heavy metal content as background samples, with the exception of zinc. The zinc content was only slightly higher than that found in background samples. Selected results from the leachate analysis are given below.

Vermillion Tunnel

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb Ppb	Zn ppb
4.17	28.5	40	4	19	73	290	16	1000

Historic Structures
Concrete foundations from a loadout or mill structure still remain at the site. Below the California Gulch access road, there are the charred remains of a wooden building. There is a small amount of mill tailings below the remains of the building. There is also considerable wooden and steel debris scattered over the area. Rails still lead from the portal.

Water Quality Impacts
Water quality impacts from this site are principally from the adit discharge. The flow from this mine has been measured between 30 gpm and 120 gpm. The pH of the drainage was measured between 6 and 6.3. Because of the high flow quantity, the adit discharge carries a significant zinc load. The zinc load from this mine varies from 0.51 ponds per day to 1.31 pounds per day. The principal metals in the adit discharge are manganese and zinc. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 1.32-3.81% of the dissolved heavy metals and about 2 to 8% of the dissolved zinc. The zinc concentrations are slightly less than the receiving stream concentrations.

It is unknown whether there is any increase in metals concentrations as the drainage flows through the waste rock. Based upon the waste rock leachate analysis, it is doubtful that there is any increase. The pond below the adit appears to be removing some metals, particularly iron and aluminum.

The measured metal loadings from this mine are given below.

Vermillion Tunnel

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	BDL	0.70	1.94	BDL	10.57	0.65	682.00	593.30
High-Flow	BDL	BDL	0.8	BDL	BDL	BDL	238.2	233.4

Reclamation Options
No reclamation is currently recommended for this site. The metals concentrations should be measured at the adit and below the waste pile to determine whether there is an increase as the drainage passes through the mine waste. If it is determined to reclaim this mine site, it is recommended that a limestone bed be placed inside the adit to provide for zinc sorbtion. The mine workings could be investigated to determine whether there are any measures that can be taken to either prevent surface infiltration into the mine, or divert clean inflows out of the mine. These approaches would significantly reduce effluent discharge, and could be the most cost-effective solutions.

Bagley (Frisco)Tunnel

Location
This site is located approximately 1/2 mile west of Animas Forks on the north side of California Gulch. The 4-wheel dive access road passes through the mine site. This site consists of a safeguarded, draining mine adit, two waste piles and a small tailing pond (Figure 28). The two waste piles are separated by the 4-wheel drive access road. The Bagley Tunnel is located at an elevation of 11,440 feet, and is believed to be on the Gorilla patented mining claim. The mill tailings are on public lands and/or the Gorilla claim. The mine site was sampled as water quality station DM-19 and as waste rock site #10 (Figures 3 & 4). The mill tailings were sampled as site #11 (Figure 4). Stream sites CG-8 and CG-9 bracket the mine site. Stream sites CG-9 and CG-10 bracket the mill tailings site. The mine site is located at LAT. N37°55'54.4", LONG. W107°34'53.2". The mill tailings site is located at LAT. N37°55'58.1", LONG. W107°34'42.6".

Workings
The Bagley Tunnel, formerly known as the Frisco Tunnel, is a long crosscut adit driven to open up veins at depth in the Burrows Creek-Mineral Point area to the northwest. The portal is at an elevation of 11,440 feet on the north side of California Gulch, ½ mile above Animas Forks. The adit was driven straight on a heading of N. 42° W. through the Eureka Tuff for 5,800 feet, and by 1908, had cut the Del Norte vein under Burrows Creek (Figure 27).

Drifts were turned on several veins intersected by the crosscut. At 2,500 feet from the portal, the Morgan drift follows the subsurface extension of the Hadley vein an aggregate 600 feet both north and south of the crosscut. The Sewell drift turns north on the Sewell vein 4,135 feet from the portal. The Red Cloud drift turns north off the crosscut 4,550 feet from the portal, continuing 1,000 feet to the bottom of a 315 foot raise, which connects to the 3-level of the Red Cloud Mine in Burrows Creek. Further on at 5,125 feet from the portal, the Non-Such drift turns north and developed the Dakota and Dolly veins. At the face of the crosscut 5,800 feet from the portal, the Dakota drift was turned 90° to the northeast. It drifted some 600 feet on the Del Norte vein. In all there are about 9,000 feet of underground workings on this tunnel level.

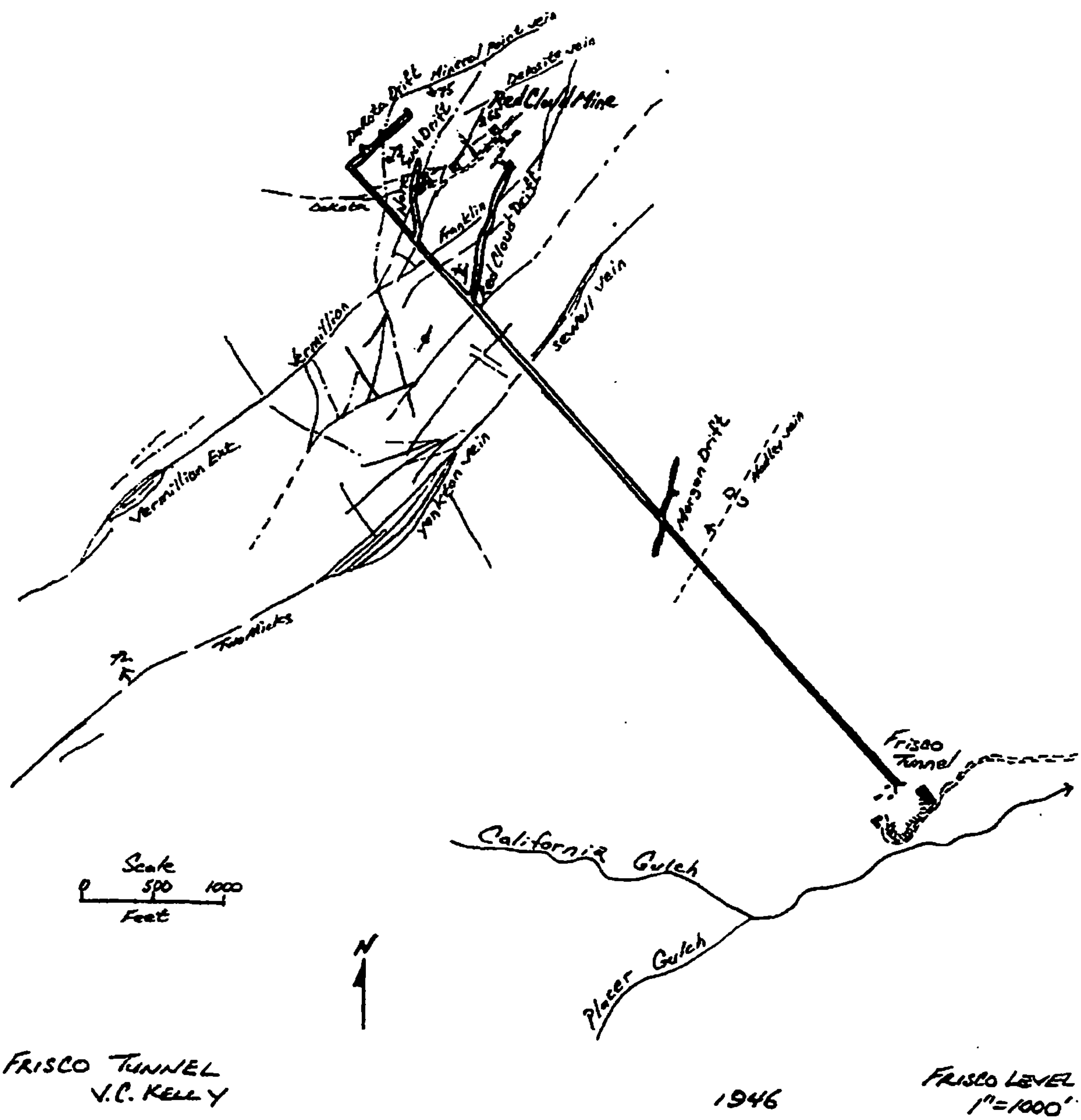


Figure 27. Mine Map of the Bagley (Frisco) Tunnel

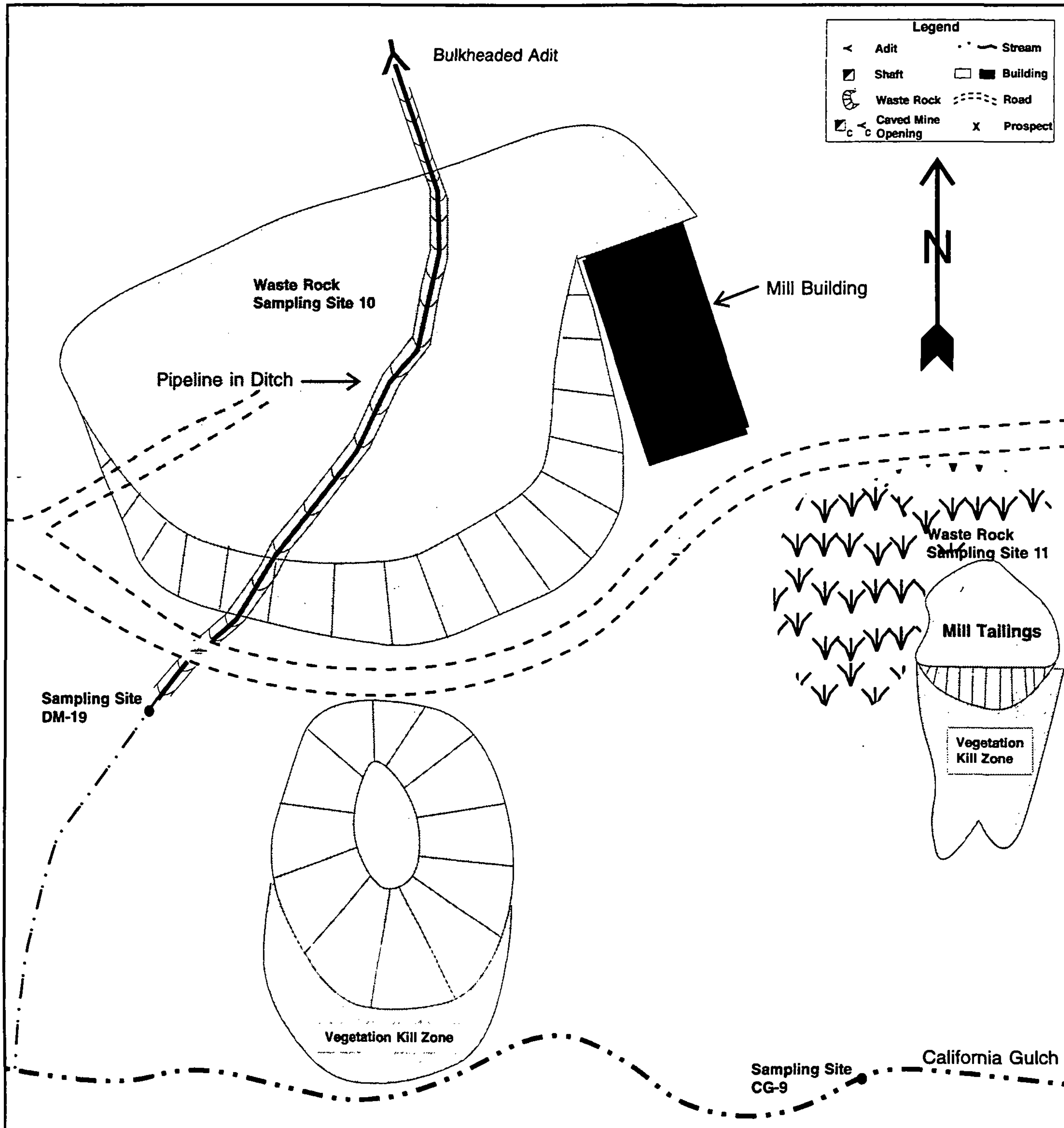


FIGURE 28

Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program

Bagley Mine Site Map
California Gulch
Animas Project

Scale	Date	Sheet No.
n.t.s.	4/99	1 of 1

From 1913 through 1914, 7,166 tons of ore were produced from the various veins serviced by the tunnel. This ore yielded 92.5 oz. gold, 13,363 oz. silver, 11,177 lbs. copper, 326,404 lbs. lead, and 119,451 lbs. zinc (Burbank and Luedke, 1969).

Mine Wastes

The waste rock consists of two piles separated by the 4-wheel drive access road. Combined quantity of the waste piles is approximately 20,500 cubic yards. The waste rock is dominantly country rock from the crosscut adit, but does contain some waste that is pyritic, with sphalerite and some galena and chalcopyrite. Leachate analysis indicates that the waste rock is not a major source of heavy metals. The southern pile appears to be more mineralized than the main, northern pile. Twenty samples were taken and composited for leachate testing.

The mill tailings at this site are located approximately 150 yards southeast of the main pile in a small valley. A dam was constructed to impound the mill tailings, which are kept continually wet by seepage from a wetland above them. Although the leachate analysis does not show the tailings to be particularly acid forming, there is a large vegetation kill zone below the site. The leachate analysis also shows that the mill tailings are not relatively high in heavy metals. The volume of mill tailings is estimated to be 1,500 cubic yards. Drilling will have to be done to verify the depth of the tailings. Selected results from the mine waste leachate analysis are given below.

Bagley Tunnel Waste Rock

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb Ppb	Zn ppb
4.3	ND	76	8	38	81	1000	380	2100

Bagley Tunnel Mill Tailings

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb Ppb	Zn ppb
4.01	15	130	9	180	160	190	13000	1800

Historic Structures

The Bagley Tunnel is one of the most visited historic sites in the Animas River Watershed. Most of the mill building and portions of some of the equipment, such as concentration cones are still in place. The structure is visible from Animas Forks, which draws thousands of tourists each summer.

Geologic Constraints to Reclamation

There are no specific geologic hazards affecting the site. Snow slides from Houghton Mountain above the site are minor, and do not seriously affect the site, as demonstrated by the still-standing mill building. Access to the site is excellent, and there is a large glacial till and outwash deposit adjacent to the mine on the valley floor. These materials could be used in construction, or for use as covering materials for the sulfide components of the dump and tailings.

Water Quality Impacts

The adit discharge, leaching of the waste rock pile, and leaching of the mill tailings all have an impact on the water quality of California Gulch. During both sampling events, approximately half of the adit discharge was conveyed across the waste rock pile by HDPE pipe. The other half was flowing out of the adit and ponding on the waste rock pile, then flowing through the mill structure to the stream. Evidently, the HDPE pipe has partially filled with iron sludge, reducing its capacity. The water ponding on the surface is undoubtedly causing some leaching of metals from the waste rock. The pond appears to be removing some iron from the adit discharge. The flow measured at this site varied between 58 and 75 gpm of pH 5.3 to 6.4 water.

The Bagley Tunnel adit discharge produces approximately 4.5 to 9 pounds of metals per day, dominated by zinc and manganese. From the iron staining in the adit discharge flow path, it appears that the mine drainage is very high in iron, but surprisingly, there is very little iron in the discharge. The Bagley adit discharge produces approximately 2.5 to 3 pound of zinc per day. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced approximately 9 to 13% of the dissolved heavy metals. This mine site produced about 10 to 17% of the dissolved zinc and 21 to 23% of the manganese load from adit discharges in the Upper Animas River. There is a measurable increase of 10 to 12 pounds of zinc per day in California Gulch below the Bagley Mine site. The measured metal loadings from this adit discharge are given below.

The mill tailings pile is undoubtedly contributing heavy metals to California Gulch. The mill tailings were placed in an area that is believed to be a historic wetland. During most of the year, there is visible flow in the area above the mill tailings.

Bagley Tunnel

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	49.56	BDL	4.11	BDL	77.47	BDL	2791.36	1347.03
High-Flow	26.2	BDL	2.1	BDL	42.8	BDL	2062.7	1151.9

Reclamation Options

The major metal of concern in the adit discharge is zinc. Zinc concentration in the adit discharge is generally 3 to 6 times the stream concentration. There is insufficient iron in the adit discharge to allow for co-precipitation of zinc in a pond, but a pond could be constructed near the adit to allow for precipitation of metals. The mine drainage then can be conveyed around the waste rock pile to California Gulch. Precipitation of zinc can be slightly enhanced by constructing an anoxic limestone drain in the mine adit and constructing a sorbtion bed below the settling pond. The settling pond should be lined to prevent water movement through the waste rock pile.

The mine workings of the Bagley Tunnel should be investigated to determine whether some or all of the metals source areas can be sealed off, or relatively clean water can be diverted/ piped to the adit entrance before it comes in contact with contaminants. This could be the most cost-effective method of reducing heavy metals loading.

If the treatment methods above cannot achieve the desired metals reduction, constructing a small-scale neutralization plant can treat the adit discharge. Power for the plant could be a combination of solar and low-head hydro-power.

Because of the historic nature of the Bagley site, no reclamation of the waste rock is recommended, except to apply ground limestone to the south side of the southern waste pile and revegetate the small vegetation kill zone below the pile. Excess limestone should be applied below the pile to aid in removal of any leached metals. The limestone will probably have a useful life of less than ten years, then replacement will be necessary.

The historic significance of the Bagley mill tailings should be determined before choosing a reclamation method. If the mill tailings are determined to be a contributing resource to the Bagley site, the mill tailings should be reclaimed in-situ. In-situ reclamation could be done by injecting grout. The type of grout would have to be determined based upon the physical characteristics of the mill tailings (ie. the relative content of slimes and sands). Alternatively, if the mill tailings are determined to be non-contributing, the best reclamation method would be to move the tailings to a relatively high and dry site nearby, or move the tailings to a repository.

Columbus Mine

Location

The Columbus tunnel site is located across the stream in California Gulch from Animas Forks at an elevation of 11,240 feet (Figure 29). This site is believed to be on the Dakota and Valkyre patented mining claims. The adit at this site crosscuts northwards to ore bodies located along the Animas River upstream of California Gulch. This site was sampled as water quality station DM-20 and as waste rock site #13 (Figures 3 & 4). Stream sites CG-11 and CG-12 bracket the mine site. The site is located at LAT. N37°55'59.7", LONG. W107°34'14.7".

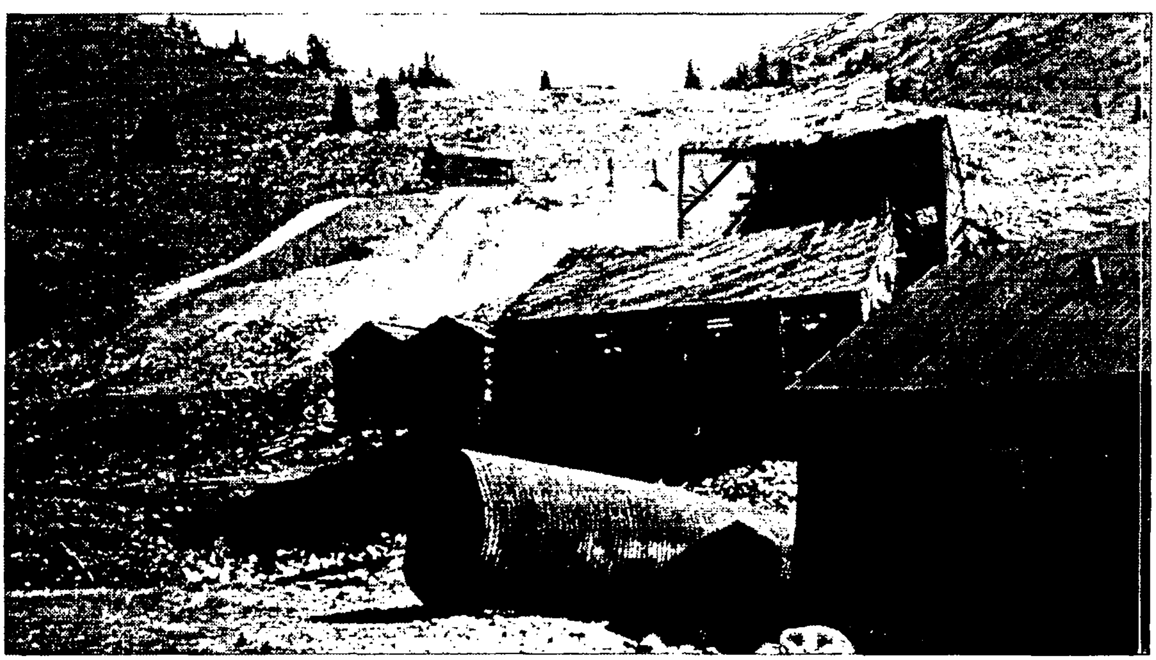


Figure 29. Columbus Mine Site

The main mine workings of the Columbus Mine are shown on Figure 4 as waste rock sampling sites #25, #26, #27 and #43. These sampling sites are discussed later in the section entitled "Other Sites of Interest".

Geology and Mine Workings
The Columbus Mine developed a large fissure vein which trends N. 50° E. across the southeastern shoulder of Houghton Mountain, crossing the Animas River to continue on Wood Mountain as the "Yellow Rose of Texas" vein. The Columbus vein dips 65° to 70° SE. Quartz -sulfide ores occurred in a steeply dipping gougy fracture along the vein. The ore was reported to be 8-14% combined lead and zinc, with 2 oz./ton silver. Copper content was low (King and Allsman, 1950).

The Columbus operation also worked several other veins on the steep eastern flank of Houghton Mountain, adjacent to the canyon of the Upper Animas. These include the Red Cross vein, striking northwest along the upper mountain side, dipping 70° to 78°southwest, and the western extension of the Wood Mountain fault. The Wood Mountain structure parallels the Columbus vein, but dips more steeply southeast. Numerous other short northwest-striking veins between the principal northeast trending fissures were also mined, resulting in the plexus of workings seen on the east side of Houghton Mountain above the Animas River.

The Columbus operated principally through a 1,200 foot crosscut adit driven north from the foot of Houghton Mountain at Animas Forks, at an elevation of 11,240 feet. Drifts were turned on the numerous veins intersected by the crosscut, and much drifting, raise driving, and stoping were done. Workings on the slope of Houghton Mountain consist of drifts on the veins, some of which apparently connect with winzes or stopes farther underground. It is not certain how many of these adits connect with the main Columbus adit level underground. All development was within 500 feet of the surface, and several stopes have caved to the surface on the east side of the Houghton Mountain.

Since 1945, the Columbus Mine at Animas Forks has probably yielded the largest tonnage of ore than any other property in the area covered by this report. During the period from 1942 to 1948, up to 6,000 tons of zinc-lead ore a year were produced from the mine. It eventually closed in 1948 after premiums for lead and zinc were discontinued (Colorado Mining Association, 1949).

Mine Wastes
The waste rock at the Columbus Mine is on two levels. The access road to the mine adit crosses the flat portion between the levels. The pile contains approximately 24,000 cubic yards of fine to coarse sulfide waste containing pyrite and sphalerite, and some calcopyrite and galena. Runoff from the waste rock pile flows directly into California Gulch. Much of the runoff water is channeled by access roads at the site. The leachate analysis shows that the waste is high in copper and zinc. Selected results from the leachate analysis are given below.

Columbus Mine Site #13

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
4.2	350	440	54	660	190	1.8	1000	10000

Historic Structures
There are four structures remaining on this site. Near the adit entrance, two wooden buildings still stand in good shape. Between the upper and lower levels, there are two loadout structures still standing. This site is heavily visited by tourists because of the close proximity of Animas Forks.

Geologic Constraints to Reclamation

There are no specific geologic hazards affecting the main Columbus adit site. Snow slides from Houghton Mountain above the main adit are minor, and do not seriously affect the site. Access to the adit site is excellent, and the portal and mine site are situated in a large, relatively thick deposit of glacial till and outwash. These materials can be excavated, and could be used in construction, or for use as covering materials for the sulfide components of the dump.

Water Quality Impacts

Water quality impacts associated with the Columbus are from the mine waste pile and adit discharge. The flow from the mine has been measured to vary from 1.5 to approximately 6 gpm. The pH of the adit discharge varied between 2.9 and 3.3. The mine drainage exits the adit and quickly infiltrates into the pile. There are a series of seeps below both levels of the waste rock pile that may be from the adit discharge.

Compared to all the adit discharges in the Upper Animas River, this adit discharge produced approximately 8-16% of the dissolved heavy metals. This adit discharge produced about 23 to 32% of the dissolved zinc, 20 to 39% of the dissolved copper and 11 to 19% of the dissolved aluminum load from adit discharges in the Upper Animas River. The adit discharge had the highest concentrations of aluminum, cadmium, copper, iron, and aluminum measured in the Upper Animas River. Overall, the adit discharge produces approximately 6 to 12 pounds of metals per day.

Dissolved metal concentrations in the adit discharge are higher than found in the waste rock leachate. This suggests that there is some loss of metals as the adit discharge passes through the waste rock, and that the waste rock pile may be acting as a treatment mechanism on the adit discharge. Leaching of metals from the waste rock by snowmelt and precipitation events probably exceeds the amount precipitated from the adit discharge. This site exhibits considerable runoff from the mine site, particularly during snowmelt. This relatively clean source water leaches metals from the waste rock pile directly into California Gulch. There is a large hillside watershed above the mine that directs runoff water onto the waste rock during snowmelt and thunderstorms. This local watershed probably doubles or triples the amount of water reaching the waste rock. The measured metal loadings from this mine are given below.

Columbus Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	138.56	0.21	7.61	56.59	568.40	2.59	99.94	1819.54
High-Flow	276.4	BDL	2.5	145.7	1147.0	23.3	179.1	3924.7

Reclamation Options

Reclamation should be done to control the impacts from the waste rock and the adit discharge at this site. Because the flow from this adit is small (1.5-6 gpm), the heavy metals contribution from this site should be significantly reduced by constructing a settling pond partially filled with limestone. The pond must be lined and should be large enough for at least 7 days residence time during high-flow. This would require a pond with approximate dimensions of 30' X 100'. During the low-flow period, the pond would have a residence time of approximately 2 months. This would allow ample time for limestone to dissolve in the acidic water. The limestone will have to be placed along the edges of the pond to allow precipitate to fall to the bottom. Over a period of time, the limestone will coat with precipitates, requiring replacement. Cleanout of the accumulated sediments can occur at the same time. During the late summer, there may be no discharge from the pond, because evaporation may exceed inflow.

A variant of this treatment method would be to construct two ponds. The first pond would be completely filled with ¼ to ½ inch diameter limestone, and the second would be a settling pond. The limestone pond can be constructed with a compressed air system to clean accumulated sediments from the limestone. A small solar or wind powered air compressor would be attached to a high volume tank. Periodically, when the compressed air reaches the desired pressure, a relief valve would release air into a series of perforated pipes at the bottom of the limestone pond. The resulting turbulence would abrade the limestone and cause precipitated metals to flow into the settling pond. This system would require less settling time than a single pond system.

An anoxic limestone drain can be constructed in the adit to aid in alkaline addition for either of the above systems. If a large anoxic limestone drain can be constructed in the adit, there may be no need for a second limestone pond. The competence of the tunnel will have to be investigated to determine whether it is feasible to construct an anoxic limestone drain.

Another potentially feasible treatment alternative is to construct an alkaline addition system. The system could be hydro-powered, or possibly solar powered.

Diverting the runoff from the slope north of the mine adit can significantly reduce impacts from the waste rock. In several places, rock outcroppings may make construction of a diversion ditch difficult. Fill will have to be imported from some of the areas where the soil is deep enough to generate excess fill. The diversion ditch can be constructed to direct half of the runoff to the east and half to the west.

Because of the historic nature of this site, relative to the town of Animas Forks, the waste rock cannot be removed. Ground limestone can be added to the top portion of the waste rock pile to buffer the water infiltrating the waste rock. Over a short period of time, the limestone will partially coat and take on the appearance of the waste rock. As an alternative, the waste pile can be injected with a lime/fly ash mixture to cement the top of the pile, but due to the large dump footprint, this would be expensive.

PLACER GULCH

Location

Placer Gulch is a tributary to California Gulch. The confluence of the two streams is located approximately 1 mile west of Animas Forks. Heavy metals in Placer Gulch principally come from four mining sources and unquantified groundwater inflow sources. Two of the mine sites, the Gold Prince, and Sunbank Property, have been partially reclaimed by the property owners. The remaining, known mining sources are the Silver Queen Mine and the Sound Democrat Mine. These sites are shown on Figures 2 and 3. The mines are situated on privately owned patented mining claims. Coordinates of each site are given in the individual site descriptions, which follow below. The Silver Queen and Sound Democrat mines can account for a maximum of 5.6% of the zinc and 35% of the manganese measured at the mouth of Placer Gulch at low-flow. During high-flow, the adit discharges can account for only 1.3% of the zinc and 2.8% of the manganese.

Only one stream station was monitored in Placer Gulch. It was decided not to monitor the upper portion of Placer Gulch because construction activities were occurring at the Gold Prince Mine during the low-flow sampling, and there was probably a larger than normal flush of metals from the construction site during the high-flow sampling.

Geologic Setting

The principal geologic feature of interest in Placer Gulch is the Sunnyside Fault zone, which forms the northern margin of the Eureka Graben structure. This mineralized fault system extends northeast from the Sunnyside mine workings at Lake Emma, across the southeast shoulder of Hanson Peak into the head of Placer Gulch. The surface trace of the fault system runs along the valley floor of the upper gulch, then climbs the northwest slopes of Treasure Mountain. The fault offsets younger Burns Formation dacites and rhyodacites in the graben on the southeast side of the fault, downward against the underlying Eureka Tuff. The structure controls much of the fracturing style, and subsequently, position and orientation of the mineralized veins in Placer Gulch.

The Eureka Tuff outcrops at the mouth of the gulch and along the lower northwest valley wall. Burns formation lava flows overly the tuff in the northwest valley wall, capping California Mountain. Rhyolite flows in the upper Burns formation cap parts of the high ridge between Placer Gulch and Parson and Picayune gulches, with lower Burns dacites and rhyodacite flows outcropping on the north slopes of Treasure Mountain south of the Sunnyside Fault.

A younger intrusive rhyolite body caps the west shoulder of California Mountain on the valley slopes above the Gold Prince Mine.

Placer Gulch lies across the northern margin of the Eureka Graben structure discussed previously. (Figure 2). There are two dominant vein sets in the gulch: 1)- a set of major northeast- striking fissures in or running parallel to the Sunnyside Fault system; 2)- a north-northwest trending minor vein set running across the gulch nearly at right angles to the controlling Sunnyside structure, as exemplified by the Silver Queen vein.

Prominently visible silicified fissure veins of the first group crop out along the upper valley floor. These veins are characterized by manganese-stained, hard, resistant white quartz ribs that can be traced through the length of the gulch. This principal vein system was the focus for prospecting and mining at the head of Placer Gulch.

Surficial Geology

Unconsolidated deposits cover less than 30% of the surface in Placer Gulch. A thick, extensive apron of talus mantles much of the upper valley walls and floor below the headwall of Placer

Gulch in the vicinity of the Silver Queen and Sound Democrat workings. A large landslide on the northern slope of Treasure Mountain extends down onto the valley floor about midway up the gulch. A large deposit of glacial till and morainal debris remains near the middle of the valley floor below the Silver Queen and Sound Democrat mines, and glacial and alluvial gravels and debris cover the valley floor almost its entire length.

Placer Gulch Site Descriptions

Silver Queen Mine

Location

This site is located near the headwaters of Placer Gulch at an elevation of 12,280 feet. It is presumed to be on the Silver Queen patented mining claim. This site was sampled as water quality station DM-25 and as waste rock site #14 (Figures 3 & 4), and is located at LAT. N37°54'26.6", LONG. W107°35'44.7".

Geology and Mine Workings

Workings of the Silver Queen Mine consist of three adits and associated waste rock piles (Figure 30). The main adit drifted southeast at an elevation of 12,283 on an irregular lode striking N.10° W. The vein is reported to dip westerly at an unusually flat 40° to 50° (Ransome, 1901). A fair amount of development was carried out underground on two levels, but apparently was somewhat random. A crosscut was driven southeast to cut the southern extension of the Sound Democrat vein, which outcrops east of the property.

Ore from the mine was said to contain some free gold. Ransome, 1901, reported that "the ore seen showed galena, pyrite, chalcopyrite, tetrahedrite, and sphalerite in a gangue of quartz and rhodonite, with a little rhodochrosite. Silver is said to occur largely in combination with bismuth, probably as a sulfobismuthite of lead and silver."

At present the lower adit is partially blocked by talus and rock-fall from above. Water is impounded to about a foot in depth, and a lot of dripping and trickling inflows were seen in the back near the portal. Drainage exits the portal through the sloughed debris, then infiltrates rapidly into the coarse dump materials. Most of the flow seems to be occurring through the very porous, cobbly sloughed materials, then into the dump where it can't be seen or quantified.

Mine Wastes

The waste rock pile is located on a steep 40°slope. The three waste rock piles are estimated to contain 15,000 cubic yards of fine to coarse waste rock composed of rhodonite with calcopyrite, and sphalerite. Leachate analysis of the waste rock shows high levels of manganese, zinc, and copper. This is consistent with the mineralogy of the waste rock. There is a small kill zone below the waste rock pile. The lower third of the lowest waste rock pile is heavily stained by manganese. The adit discharge quickly infiltrates into the waste rock after exiting the mine adit. Selected results from the leachate analysis are given below.

Silver Queen Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
4.14	29.8	570	28	320	110	34000	93	10000

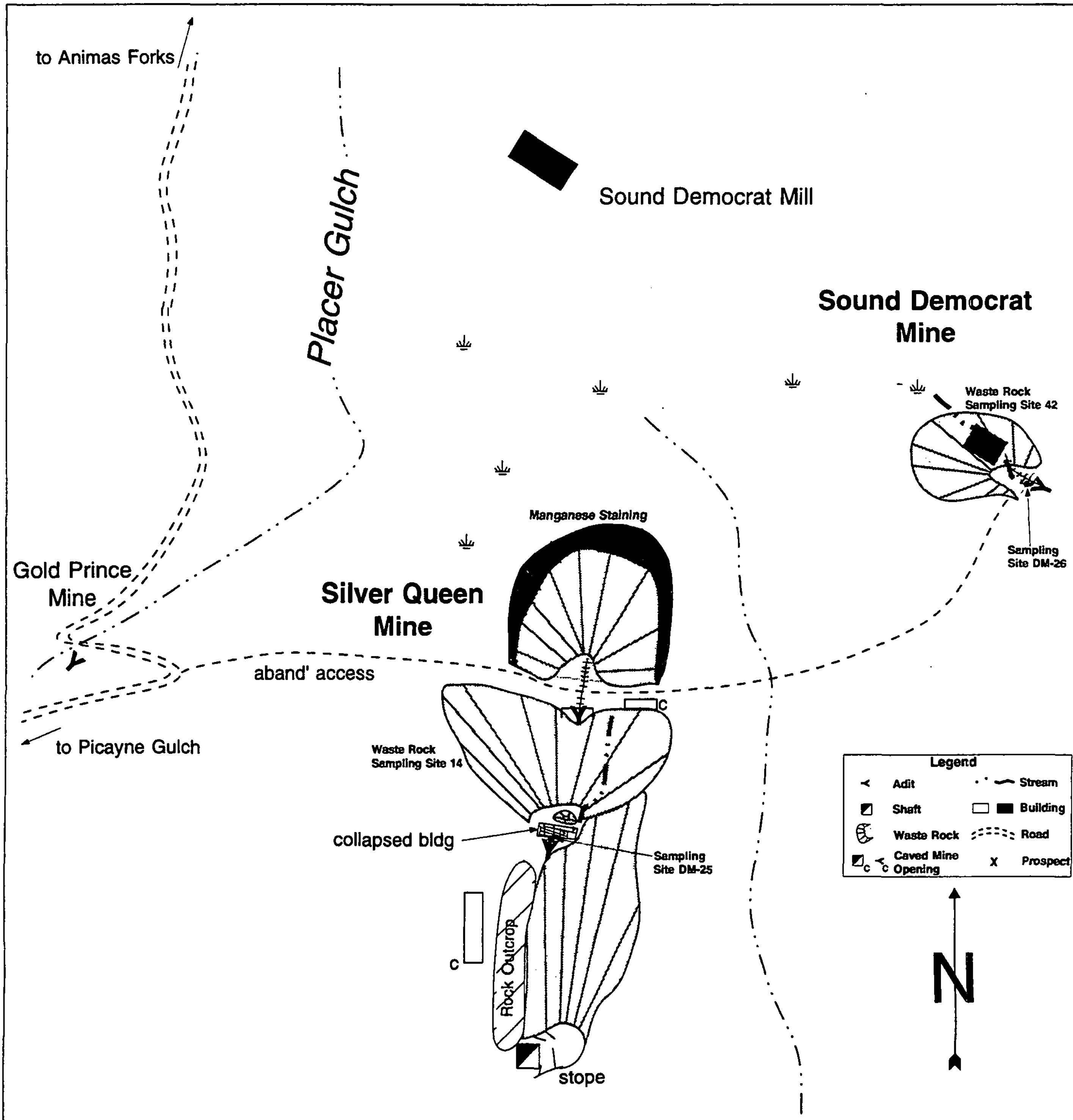


FIGURE 30		
Colorado Department of Natural Resources Division of Minerals and Geology **Inactive Mine Reclamation Program**		
Silver Queen and Sound Democrat Site Map Placer Gulch Upper Animas River Project		
Scale 1"= 300'	Date 4/9/99	Sheet No. 1 of 1

Historic Structures
A shop and portal shed have been flattened by avalanches. Other than some scattered iron and wood parts and debris on the dump, nothing else remains.

Geologic Constraints to Reclamation
This site is exposed to extreme avalanche and rock-fall hazards from the slopes above. Access is good from the Gold Prince site, but would need some improvement. Slopes are very steep, and there is no area for any treatment facilities unless a bench is constructed. An extensive loose, blocky talus deposit covers the slope below the portal all the way to the creek.

Water Quality Impacts
Water quality impacts from this site are believed to be principally from the adit discharge. The measured flow from this mine site varied between 0.35 and 4.4 gpm of pH 3.3 to 3.4 water. However, it appears that most of the drainage was infiltrating into the talus deposit at the mine entrance before it could be measured. There is likely some leaching of metals from the waste rock by snowmelt and thunderstorms. The distance any leachate has to travel to the stream tends to minimize the impacts from the mine waste. CDPH&E data from 1991 and 1992 indicates that there is a significant increase in zinc loading in the stream segment bracketed by this mine site and the Sound Democrat mine site during a precipitation event and during a high-flow sampling. It is unknown whether this is principally due to the mine sites or groundwater inflow sources. The measured metals loading from the site was approximately 0.4 to 1.25 pounds per day. Manganese was the principal dissolved metal in the adit discharge. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.5-1.44% of the dissolved heavy metals. The measured metal loadings from this mine are given below.

Silver Queen Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	2.34	0.00	0.05	3.97	26.44	0.61	122.67	14.42
High-Flow	12.6	BDL	0.2	22.6	162.3	1.9	256.1	59.8

Reclamation Options
Reclamation at this site will be difficult. During most years, the mine is covered with snow at least through June. At a minimum, the adit discharge should be collected and routed around the waste pile to the channel to the east. The recommended method of treating the adit discharge is to construct an anoxic limestone drain inside the mine adit. A settling pond probably is not necessary, given the long flow path to Placer Gulch.

This site should be investigated further to determine what the actual flow is from the mine adit. Also, Placer Gulch should be monitored further to determine whether there is any measurable loading from the Silver Queen and Sound Democrat waste rock piles.

If it is determined that the waste rock pile must be reclaimed, the waste piles can be slushered down onto the access bench and removed, or consolidated.

Sound Democrat Mine

Location
This site is located near the headwaters of Placer Gulch approximately 50 yards east of the Silver Queen Mine at an elevation of 12,280 feet. This site is believed to be on the Sound Democrat patented mining claim. This site was sampled as water quality station DM-26 and as waste rock site #42 (Figures 3, 4 & 30). The site is located at LAT. N37°54'31.5", LONG. W107°35'40.6".

Geology and Mine Workings
The Sound Democrat is another small mine which produced high-grade ores early in the history of the area. This mine was examined by F.L. Ransome of the U.S. Geological Survey in 1899. He reports:

The Sound Democrat was being developed in 1899. The principal lode strikes N. 20° E and dips northwest about 68°. The portion of the lode now being worked is very irregular, the ore occurring in bunches, as if the vein had been broken up and the parts displaced. Much of the irregularity seems due to the fact that two or more transverse intersecting veins occur in the workings. In its general character, the vein resembles those of the Sunnyside mine. The ore shows galena, pyrite, chalcopyrite, sphalerite, and free gold in a gangue of quartz and rhodonite, with a little rhodochrosite. Gold occurs free as fine particles in the quartz and pyrite. Chalcopyrite is not abundant, and when seen, is taken to be an indication of gold. Vuggy quartz is the principal gangue mineral. In 1899 the ore of the Sound Democrat was being packed on burros to the upper Sunnyside mill in Eureka Gulch for treatment.

At present the lower adit is partially blocked by talus and rock-fall from above, and can not be entered. Water is standing inside on the adit floor to several inches depth. Drainage exits the portal through the sloughed debris, then infiltrates rapidly into the coarse dump materials. An upper collapsed adit appears to have had some stoping done on the vein near the portal.

Mine Wastes
The waste rock pile at this site contains approximately 14,000 cubic yards of fine to coarse waste rock consisting of rhodonite with small amounts of pyrite and sphalerite. The acidity and metals concentrations in the leachate were well below the average for all the sites sampled. Zinc and manganese were the only metals higher than the background samples. Selected results from the leachate analysis are given below.

Sound Democrat Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn Ppb
3.8	103	110	2	30	75	910	BDL	310

Historic Structures
Avalanches have smashed several structures on the mine site. There is considerable scattered wooden and iron debris on the site.

Geologic Constraints to Reclamation

This site is exposed to extreme avalanche and rock-fall hazards from the slopes above. Access is good from the Gold Prince site, but would need some improvement. Slopes are very steep, and there is no area for any treatment facilities unless a bench is constructed. An extensive loose, blocky talus deposit covers the slope below the portal all the way to the creek.

Water Quality Impacts

Water quality impacts from this site are principally from the adit discharge. Based upon the waste rock leachate analysis, the waste pile is probably a minor source of metals. The measured flow from the mine varied between 4 and 103 gpm of pH 3.7 to 4.7 water. The dissolved metals load varied between 2.5 and 5.5 pound per day. The majority of the metals load is manganese. The adit discharge quickly infiltrates into the talus material outside the adit and probably does not pass through the waste rock pile. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 3.4-7.2% of the dissolved heavy metals and 7 to 21% of the manganese. The measured metal loadings from this mine are given below.

Sound Democrat Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	29.8	BDL	0.4	5.58	5.0	- 2.9	907.9	184.5
High-Flow	149.9	BDL	1.5	31.6	17.0	BDL	2009.3	367.5

Reclamation Options

The large variation in flow indicates that there is a seasonal source of inflow to the mine workings. The inflow may be shallow groundwater near the mine entrance, or come from a fractures system fed by a snowmelt stream. The mine workings should be investigated to determine if any inflows can be sealed off or diverted. If the relatively clean inflows can be sealed off or diverted, construction of an anoxic limestone drain is recommended. Because of the long distance to the stream, no settling pond would be necessary. No reclamation is recommended for the waste rock pile.

ANIMAS RIVER BELOW ANIMAS FORKS

Location

The section of the main stem of the Upper Animas River below Animas Forks is discussed separately because, in general, water quality steadily improves downstream from Animas Forks. This section of stream starts at an elevation of 11,120 feet at Animas Forks and ends at an elevation of 9,840 feet. The major tributaries in this stream segment include Cinnamon Gulch, Grouse Gulch, Picayune Gulch, Burns Gulch and Niagara Gulch. The maximum elevation in the Upper Animas River is 13,860 feet at the headwaters of Burns Gulch. Adit discharges in this segment include the Golden Fleece, Treasure Mountain, Toltec, Silver Wing, Tom Moore, Senator, and an unknown mine between Grouse and Burns Gulch. These sites are shown on Figures 3 and 4. The mines are situated on privately owned patented mining claims. Coordinates of each site are given in the individual site descriptions, which follow below.

The Treasure Mountain Mine was not sampled because at the time, it was believed to have been sampled by CDPH&E. Later, no data could be located to document that the adit was ever sampled. This site should be sampled at least once to determine if there are any impacts to

Picayune Gulch. Heavy metals concentrations in Picayune Gulch at the confluence with the Animas River are below chronic toxicity levels for aquatic life.

This area is characterized by rugged, steep, alpine and sub-alpine terrain. Much of the area is subject to destructive snow slides during the winter. Winters are long with snow depths averaging 440 inches, and the summer growing season is short. Average total precipitation for the past 3 years is 45 inches, 37 inches occurring as snowfall (SGC data).

Geologic Setting

The canyon section of the upper Animas study area immediately above Eureka lies in the trough of the ring-fault structure which defines the Silverton Caldera. The ring structure is here expressed by the Animas Fault system, running along the west canyon wall from the mouth of the canyon at Eureka to a junction with the Cinnamon Fault at Cinnamon Creek. The Animas Fault intersects the Toltec Fault near the mouth of Picayune Gulch. Numerous nearly east-west striking mineralized fault veins branch off the Animas Fault structure on into the east canyon wall. These veins in the Eureka Tuff were prospected and developed by several mines described in this section.

The Toltec Fault forms the southern margin of the Eureka Graben structure discussed previously. It continues across the Animas River and into Grouse Gulch, where it is known as the Anaconda Fault. The Toltec-Anaconda structure is apparently not heavily mineralized here, as none of the prospects or mines on it in the Animas canyon section produced much economic ore.

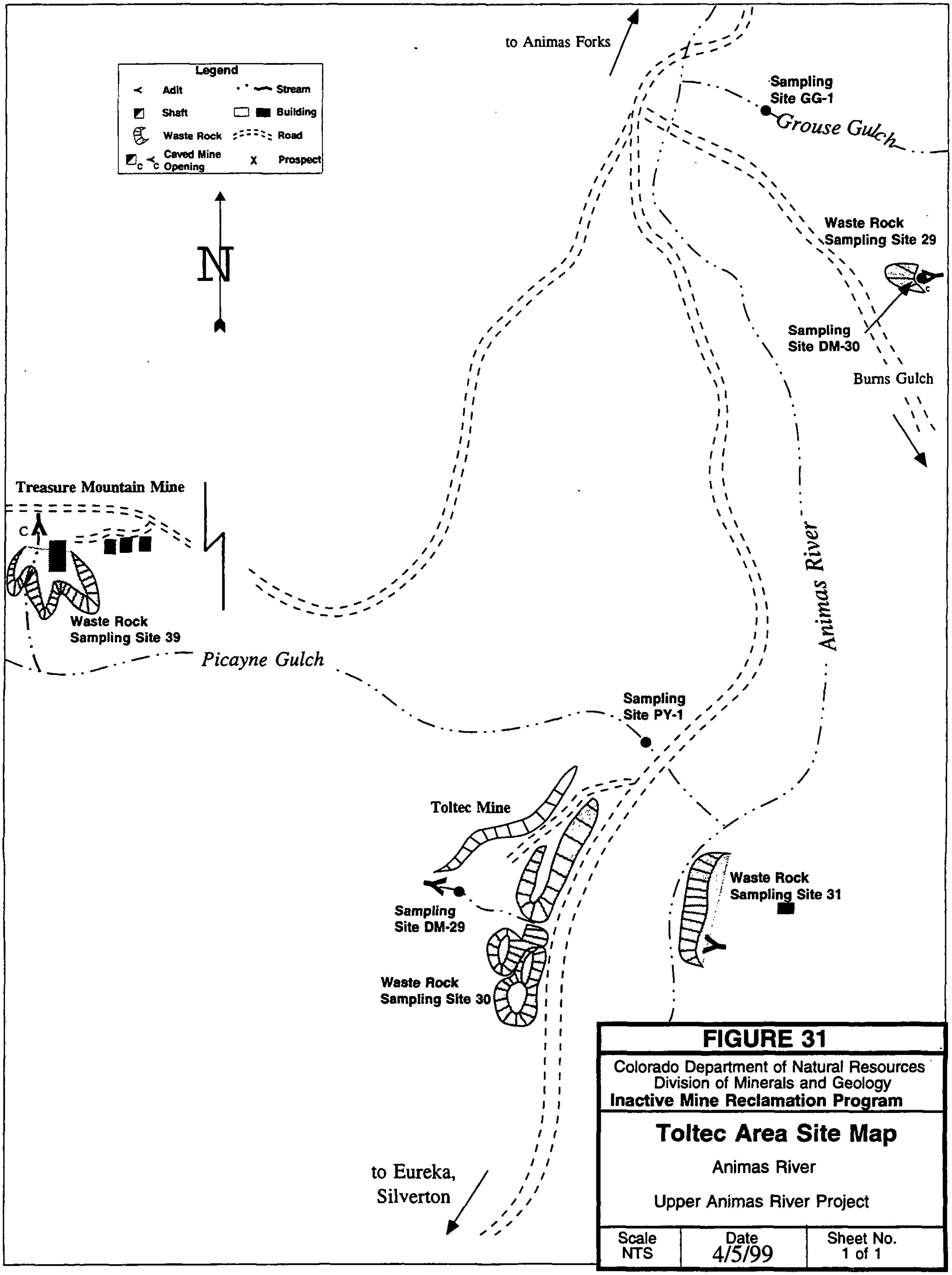
The lower canyon area near Eureka has the most extensive zones of solfataric hydrothermal alteration seen in the study area. The west canyon walls at Eureka are brightly stained red and orange, in similar fashion to hydrothermally altered rocks associated with the Red Mountain District farther west. Large zones of hydrothermally altered rock can be seen in both valley walls, and in Niagara Gulch. As discussed previously, these areas naturally have less buffering capacity, and probably contribute more background sulfate and metals than some of the other areas in this study.

Animas River Below Animas Forks Site Descriptions

Unknown Mine South of Grouse Gulch

Location
This site is located on the east side of the Animas River, approximately midway between Grouse Gulch and Burns Gulch at an elevation of 11,120 feet. This mine is believed to be on the Knox or Despised patented mining claim. This site was sampled as water quality station DM-30 and as waste rock site #29 (Figures 3, 4 & 31). The site is located at LAT. N37°54'57.3", LONG. W107°33'17.6".

Geology and Mine Workings
The adit at this site prospected the Toltec Fault. The structure cuts through the Picayune Mega Breccia unit of the Sapinero Mesa Tuff, the oldest volcanic rock exposed in the report area. The fault vein is the same as that developed in the Toltec Mine directly across the river on the west side of the valley. The fault strikes almost due east and deeps steeply north. The adit drifted for several hundred feet along the structure, judging from the size of the dump.



to Animas Forks
Legend
Adit
Stream
Shaft
Building
Waste Rock
Road
Caved Mine Opening
X Prospect
N
Sampling Site GG-1
Grouse Gulch
Waste Rock Sampling Site 29
Sampling Site DM-30
Burns Gulch
Treasure Mountain Mine
Waste Rock Sampling Site 39
Picayne Gulch
Animas River
Sampling Site PY-1
Toltec Mine
Sampling Site DM-29
Waste Rock Sampling Site 31
Waste Rock Sampling Site 30
to Eureka, Silverton
FIGURE 31
Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program
Toltec Area Site Map
Animas River
Upper Animas River Project
Scale NTS
Date 4/5/99
Sheet No. 1 of 1

At present, the adit is open, and flooded with standing water about 1 ½ feet deep. The water seeps through sloughage and debris at the portal, then flows onto the dump where most of it infiltrates. Probably more water leaves the adit via subsurface seepage than as surface flow.

Mine Wastes

Rock in the dump is weakly mineralized. It appears to be mostly propyliticaly altered volcanic breccia and tuff. Some quartz and calcite gangue with fine pyrite stingers was found, but overall the dump is relatively benign. The waste rock pile contains approximately 1,100 cubic yards of fine to coarse country rock mixed with mineralized rock containing occasional pyrite and sphalerite. The waste rock had acidity and metals concentrations in the leachate similar to the undisturbed talus and soils in the watershed. There was some vegetation growing on the mine dump. This material could be used as a source of non-toxic cover for revegetation of a mining site. The results from leachate testing of a 10-sample composite are given below.

Unknown Mine South of Grouse Gulch

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
5.44	42	130	1	8	140	95	BDL	120

Historic Structures

There are no structures or equipment, other than scattered debris.

Water Quality Impacts

Water quality impacts from this site are minimal. The flow from the mine was measured between 0.65 and 10.5 gpm of pH 6.9-7.5 water. Metals concentrations in the adit discharge were generally low with most being below detection limits. Zinc concentration at low-flow was measured at 276 ug/l, but it is likely that most of the zinc is sorbed to organics and soil particles before the water reaches the stream. The adit discharge quickly infiltrates the mine waste pile, and does not surface anywhere below the pile. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced less than 0.01% of the dissolved heavy metals. The measured metal loadings from this mine are given below.

Unknown Mine South of Grouse Gulch

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	BDL	BDL	BDL	BDL	0.02	BDL	0.56	0.88
High-Flow	BDL	BDL	BDL	BDL	BDL	BDL	0.7	0.7

Reclamation Options

No reclamation is recommended for this site. This mine apparently has a minor effect on the water quality of the Animas River headwaters.

Toltec Mine

Location
This site is located approximately 2 miles north of the Eureka townsite on the west side of the Animas River Canyon at an elevation of 10,620 feet. This mine is believed to be on the Surprise or Zula patented mining claim. This site was sampled as water quality station DM-29 and as waste rock site #30 (Figures 3, 4 & 31). The site is located at LAT. N37°54'37.0", LONG. W107°33'22.4".

Geology and Mine Workings
The Toltec adit was driven in 1907 to prospect the northeastern section of the Toltec fault system at depth. As described above, the Toltec structure is the southern margin of the Eureka Graben. The fault dips steeply northwest, down-dropping younger Burns formation rocks in the graben against the older Eureka Tuff south of the fault.

Both low-grade base metal ore shoots and lenses of high-grade tetrahedrite ores were found in the upper parts of the vein on Treasure Mountain. There the vein reaches widths of up to 60 feet of solid quartz and finely disseminated pyrite, with a strongly mineralized streak near the hanging wall carrying galena, sphalerite, and chalcopyrite (Ransome, 1901).

The adit crosscuts 1,200 feet west, where it intersects the Toltec fault system. From there it drifts S 40° W. on the structure for several hundred feet, but no economic ore was apparently ever found, as no appreciable production was ever recorded (Burbank and Luedke, 1969). The adit is open and drains across the waste rock dump.

Mine Wastes
The waste rock pile is located immediately adjacent to the main road up the Animas Canyon. The mine dump contains approximately 3,800 cubic yards of fine to coarse country rock containing small amounts of pyrite and galena. The waste rock pile appears to contain a greater quantity of material, but a large portion of the bench outside the adit is excavated colluvium. The waste rock had acidity and metals concentrations in the leachate similar to the undisturbed talus and soils in the watershed with the exception of zinc and manganese. Even the zinc and manganese concentrations in the leachate were well below the average for the watershed. Most of the waste rock pile is partially vegetated with pioneer species. The adit discharge infiltrates into the waste rock, and flows to the Animas River underground. Selected results from the leachate analysis are given below.

Toltec Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
6.52	44	30	11	3	91	1500	BDL	2600

Historic Structures
There are no structures or equipment, other than scattered debris. This mine appears to have been worked within the past 20 years.

Water Quality Impacts
Water quality impacts from this site are minimal. The adit discharge produces less than 0.02 pounds of metals per day. The measured flow from the mine adit varied from 0.75 to 10.5 gpm of pH 8+ water. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced less than 0.02% of the dissolved heavy metals. The measured metal loadings from this mine are given below.

Toltec Mine

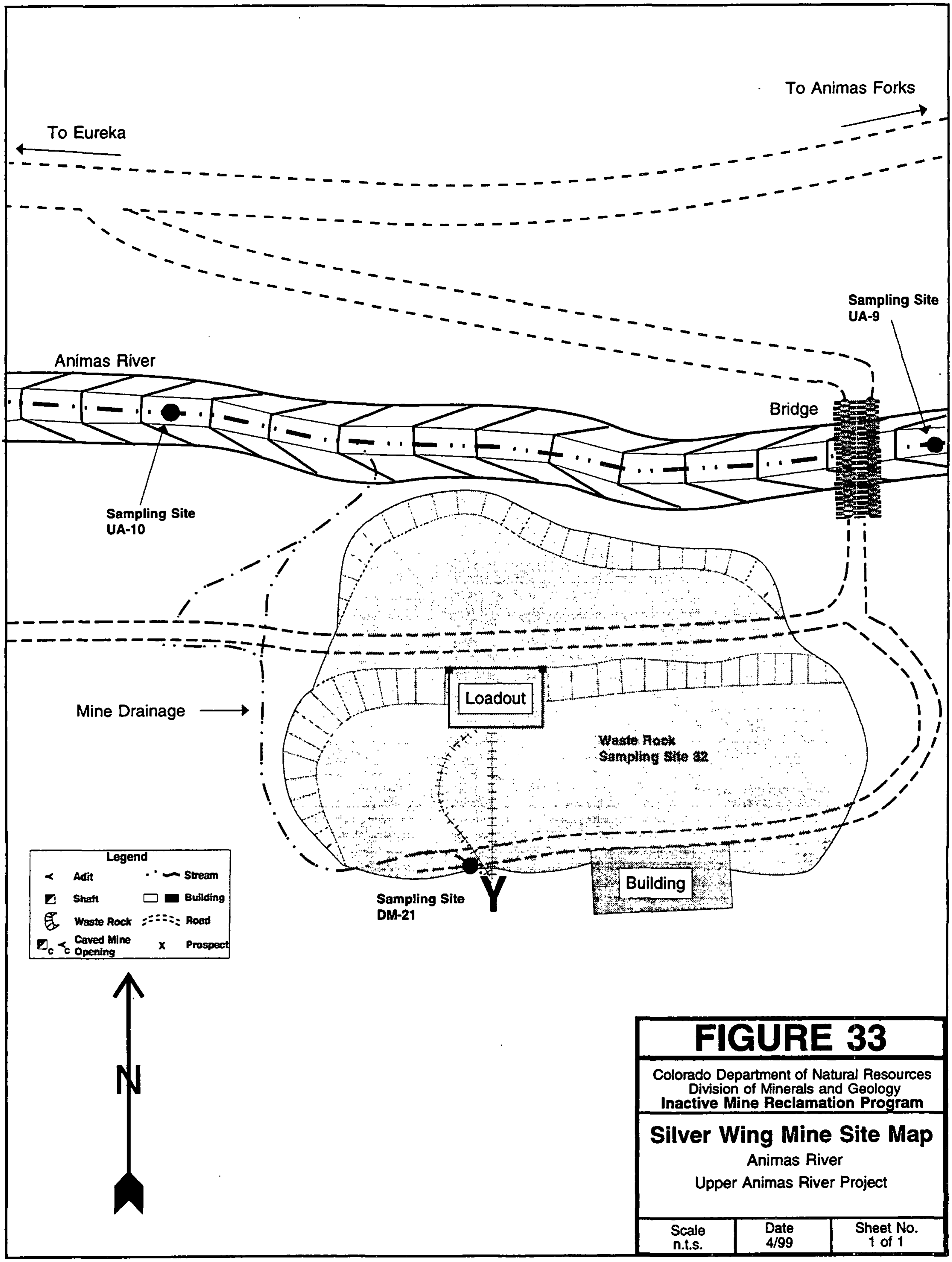
Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	BDL	0.01	BDL	0.01	BDL	BDL	0.12	0.10
High-Flow	BDL	BDL	BDL	0.2	1.7	BDL	1.4	5.2

Reclamation Options
No reclamation is recommended for this site. This mine apparently has a minor effect on the water quality of the Animas River.

Silver Wing Mine

Location
This site is located approximately 1.75 miles north of the Eureka townsite on the east side of the canyon at an elevation of 10,550 feet (Figure 32). Current access to the site is across a recently reconstructed bridge over the Animas River. This site is believed to be on the Cynic and Edward patented mining claims. This site was sampled as water quality station DM-21 and as waste rock site #32 (Figures 3, 4 & 33). The mine site is bracketed by stream sampling sites UA-9 and UA-10. The site is located at LAT. N37°54'13.7", LONG. W107°33'20.5".

Figure 32. Silver Wing Mine Site


To Animas Forks
To Eureka
Sampling Site
UA-9
Animas River
Bridge
Sampling Site
UA-10
Mine Drainage
Loadout
Waste Rock
Sampling Site 32
Sampling Site
DM-21
Y
Building
Legend
Adit
Stream
Shaft
Building
Waste Rock
Road
Caved Mine Opening
Prospect
N
FIGURE 33
Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program
Silver Wing Mine Site Map
Animas River
Upper Animas River Project
Scale
n.t.s.
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Geology and Mine Workings
The Silver Wing workings developed a parallel series of north trending veins in the canyon wall between the Animas River and Burns Gulch. These veins follow the structural trend of the caldera ring-fault system that underlies the Animas canyon here. The veins strike N 12° W. and dip vertical to steeply west. A second set of two shorter east-striking veins intersects with the north trending set, and these may also have been mined in the Silver Wing workings. The workings are driven in the Picayune andesite and flow-breccia member of the Sapinero Mesa Tuff.

The ore of the Silver Wing is highly pyritic. Massive bands and stringers of solid pyrite are intergrown with gray and white quartz. Much of the dump material is fine grained and even clayey in texture, but there are large amounts of very coarse pyritic waste in some sections of the pile. Much of the country rock in this area appears to be solfatarically altered, and this may account for the high acidity and lack of buffering capacity at this and the Tom Moore site just downstream.

Mine Wastes
The waste rock pile is located immediately adjacent to the Animas River. The pile contains approximately 10,000 cubic yards of sulfide waste rock containing pyrite, galena and sphalerite. The waste rock had some of the highest acidity and metals concentrations found in the Upper Animas watershed. The low-flow data collected in this study shows that there is a larger metal load at station UA-10 than can be accounted for by the adit discharge. This indicates that the waste pile is probably a source of heavy metals during most of the year. CDPH&E data from high-flow, low-flow, and a storm event also show a larger metal load than can be accounted for by the adit discharge. Selected results from the waste rock leachate analysis are given below.

Silver Wing Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb Ppb	Zn ppb
2.62	3534	12000	120	15000	48000	21000	2500	16000

Historic Structures
This mine has been worked in the recent past. There are several standing structures, including a loadout and partially collapsed portal shed. Several ore cars and other equipment remain.

Water Quality Impacts
The drainage from the mine adit and leaching and runoff from the waste rock pile have an impact on the Animas River water quality. This is one of the few mine sites where there is a measurable increase in metals loading that can be directly attributed to the mine site. As discussed above, the waste rock pile is apparently a source of metals for most of the year. The mine drains approximately 10 to 19 gpm of pH 6.5 to 6.8 water as measured in this study. CDPH&E data shows that the flow has reached as high as 28 gpm. Also, there was no drainage from the mine during a site visit in August of 1996. The metals loading measured by DMG is significantly less than previously measured by CDPH&E. The DMG sampling indicates that the metals load from the adit discharge was approximately 1.5 to 2 pounds per day. The load measured by CDPH&E was approximately double that measured by DMG. It is unknown what is the cause of the apparent discrepancy. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 1.6-2.9% of the dissolved heavy metals. The adit discharge produced 39 to 44% of the dissolved copper from adit discharges in the Upper Animas River. The measured metal loadings from this mine are given below.

Silver Wing Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	36.95	0.35	1.32	124.52	167.54	BDL	310.90	349.11
High-Flow	8.2	BDL	0.6	9.1	214.7	BDL	179.8	166.9

Reclamation Options

The property owner currently has a Nonpoint Source Program 319 grant to construct a passive treatment system at this site. Project work was underway in the late summer and fall of 1999. Further work on treating or buffering the waste pile may be effective in addressing the waste rock impacts at this site.

Tom Moore Mine

Location

This site is located approximately 1 mile north of the Eureka townsite at an elevation of 10,360 feet. Access to this mine site is by a road from the Silver Wing Mine. Much of the road has been filled in with scree and talus from the slopes above. This site is believed to be on the Byron patented mining claim. This site was sampled as water quality station DM-22 and as waste rock site #33 (Figures 3 & 4). The site is located at LAT. N37°53'59.0", LONG. W107°33'31.9".

Workings

The mine apparently developed veins with similar aspect to those in the Silver Wing Mine. The veins strike roughly N 75° E. and dip 75°SW. Geology is similar to the Silver Wing Mine described above.

Mine Wastes

The waste rock pile is located immediately adjacent to the Animas River. The pile contains approximately 4,000 cubic yards of waste rock containing pyrite and sphalerite. Manganese staining is prevalent over the surface of the pile. Where avalanches have carried debris onto the pile, sparse vegetation is growing. The waste rock had some of the highest acidity and metals concentrations found in the Upper Animas River. Aluminum and manganese concentrations were the highest measured in the Upper Animas River. This mine site is subject to snow avalanches. When avalanches occur at this site, this increases the leaching of heavy metals from the waste rock pile. Selected results of the mine waste leachate testing are given below.

Tom Moore Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd Ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
2.94	2382	12000	270	760	6000	34000	1000	58000

Historic Structures

There are no structures or equipment, other than scattered debris.

Geologic Constraints to Reclamation
The site is on steep rocky cliffs above the canyon of the Animas River. It is affected by snow avalanches from both sides of the canyon walls, and debris and mudflows from steep drainages on the east side of the canyon. Access is difficult, and will need to be reconstructed from the Silver Wing Mine. There is very little room for constructing treatment or reclamation options.

Water Quality Impacts
The adit discharge and leaching of waste rock at this site impact water quality. The flow from this mine has been measured between 36 and 50 gpm of pH 7.3-7.6 water. The adit discharge produces approximately 0.6 to 0.7 pounds of metals per day. The adit discharge bypasses the waste rock pile, so there is no leaching of metal from the waste rock by the adit discharge. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.7-0.9% of the heavy metals. The measured metal loadings from this adit discharge are given below.

Tom Moore Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	BDL	BDL	0.35	BDL	2.47	BDL	94.63	148.91
High-Flow	BDL	BDL	0.5	BDL	BDL	BDL	149.5	160.6

The water quality impacts from leaching of the waste rock may be greater than from the adit discharge during certain times of the year. When avalanches deposit snow on this pile, during snowmelt, the metals load from leaching of the waste rock probably exceeds the metal load from the adit discharge.

Reclamation Options
Treatment of the adit discharge is currently not recommended because dilution by the Animas River results in an immeasurable impact. If any treatment is contemplated, it is recommended that a limestone sorbtion bed be constructed on the bench of the waste rock pile. The water flow path will have to be lined to prevent further degradation of the water quality.

The waste rock pile should be capped or neutralized/ cemented by grout injection to prevent reduce or prevent leaching of metals from the waste rock. The access road into the site will have to be improved for access by reclamation equipment.

Senator Mine

Location
This site is located near the townsite of Eureka, immediately northeast of the Eureka mill foundations at an elevation of 10,080 feet (Figures 34 & 35). It is believed to be on the Senator patented mining claim, and since the name of the mine could not be verified, the claim name is used in this report. The site was sampled as water quality station DM-24 and as waste rock site #38 (Figures 3 & 4). The site is located at LAT. N37°52'54.3", LONG. W107°34'02.4".

Figure 34. Senator Mine Site

Geology and Mine Workings
The Senator claim developed the southern end of the Animas Fault structure. Workings drifted north on the nearly vertical fissure vein, but it is not known if any significant ore values were found. Country rock here is hydrothermally altered. Solfataric processes (previously described in this report), have resulted in the bleached yellow and red-stained dump rock, and bright yellow and red altered outcrops in the canyon walls above the site. The mine adit is totally collapsed, but discharges a large flow.

Mine Wastes
The waste rock pile is located on a steep scree slope between the Animas River access road and the access road up Eureka Gulch. The waste pile contains approximately 4,000 cubic yards of fine clayey fault gouge and coarse wall rock. The waste rock was not highly mineralized, but contained some disseminated sphalerite and pyrite. The drainage from the mine passes over and through the waste rock pile. The waste rock appears to be removing iron and aluminum from the adit discharge as evidenced by precipitates observed on the waste rock. Compared to the other

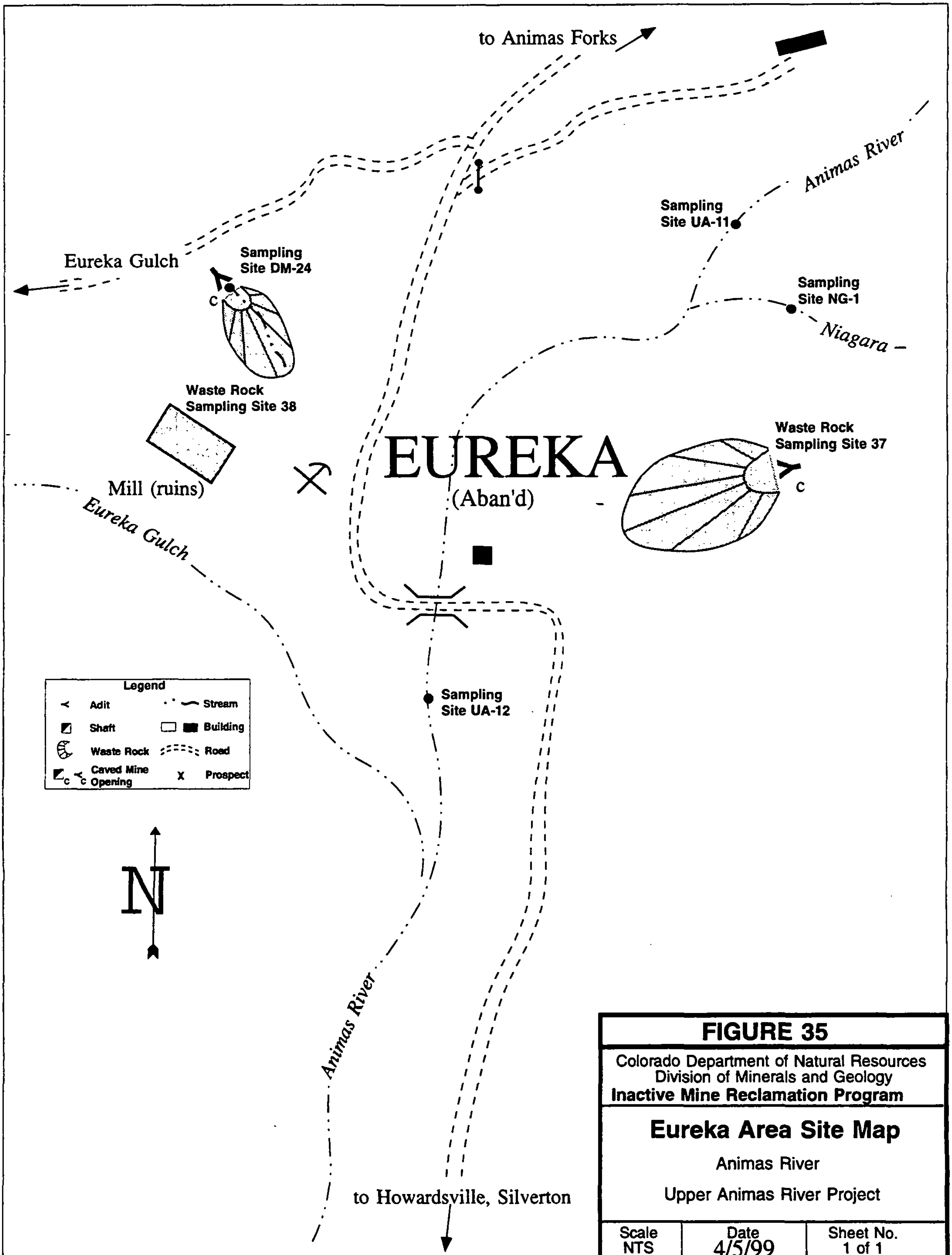

FIGURE 35

Colorado Department of Natural Resources
Division of Minerals and Geology
Inactive Mine Reclamation Program

Eureka Area Site Map

Animas River

Upper Animas River Project

Scale	Date	Sheet No.
NTS	4/5/99	1 of 1

waste rock pile sampled in the Upper Animas River, the waste rock from this mine is only higher than average in acidity, aluminum, and manganese. Selected results from the waste rock leachate analysis are given below

Senator Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.46	247	1200	4	140	120	1600	32	830

Historic Structures

There are no structures or equipment, other than scattered debris.

Geologic Constraints to Reclamation

The mine is located on steep, loose slopes of talus and scree, subject to rockfall and snowslides. Access is good via an old road level from the Eureka Mill site, or from the foot of the slope.

Water Quality Impacts

The principal water quality impact from this mine appears to be the adit discharge. As the adit discharge passes through the mine waste pile, it appears that metals are removed rather than leaching additional metals. During low-flow, it has been observed that the adit discharge infiltrates the waste rock pile, flowing into the surrounding scree. During high-flow, the adit discharge flows beyond the waste rock pile, but quickly infiltrates the coarse scree. The adit discharge has been measured to vary between 73 and 86 gpm of pH 6.6-6.7 water. The adit discharge is principally a source of aluminum, manganese and iron. The adit discharge contains approximately 29 to 40 pounds of heavy metals per day. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced approximately 37-54% of the dissolved heavy metals. During low-flow, this adit discharge produces approximately 51% of the dissolved aluminum, 85% of the dissolved iron, 53% of the dissolved manganese and 10% of the dissolved zinc from the adit discharges in the Upper Animas River. During high-flow, this adit discharge produces approximately 9% of the dissolved aluminum, 75% of the dissolved iron, 35% of the dissolved manganese, and 2% of the dissolved zinc from adit discharges in the Upper Animas River. The measured metal loadings from this mine are given below.

Senator Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	668.25	0.56	1.56	3.19	10556.42	2.71	6251.66	751.24
High-Flow	132.7	BDL	BDL	BDL	9577.0	BDL	3368.3	188.3

Reclamation Options

No reclamation is recommended for this site. Natural processes may be treating the water. The high iron-zinc ratio and high pH indicate that there probably is considerable co-precipitation of zinc as iron precipitates on the waste rock and scree. Also, manganese can be removed by sorbtion to the scree. It is likely that most of the manganese and some of the zinc reaches the Animas River, but the concentrations can only be measured by installing and monitoring groundwater wells. If any reclamation is done to this site, it should be limited to diverting the adit discharge from the waste rock pile directly onto the surrounding scree.

Mill Tailings North of Grouse Gulch

Location
Approximately 300 cubic yards of black mill tailings are located between flow channels in the Animas River above Grouse Gulch at LAT. N37°55'29.2", LONG. W107°33'44.0". The mill tailings were sampled as site # 28 (Figure 4). The mill tailings are easily accessible. The source of the mill tailings is unknown.

Reclamation Options
There is evidence that the tailings are eroded during high-flow periods. Selected results from leachate analysis of the mill tailings are given below. The mill tailings are high in lead and zinc, and should be removed and consolidated in a disposal area away from the river.

Mill Tailings Site #28

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
5.43	256	96	87	350	74	23	3200	12000

Protection Mine

The name of this mine could not be verified. It is located immediately east of the Eureka Townsite at an elevation of 10,000 feet (Figure 35). The mine site consists of a collapsed adit and large waste rock pile. The mine site is located at LAT. N37°52'48.7", LONG. W107°33'48.6". The waste rock was sampled as site #37 (Figure 4).

The waste rock pile is stratified, consisting of approximately 20,000 cubic yards of country rock mixed with mineralized waste rock. Leachate analysis shows that the waste rock is high in aluminum, cadmium, manganese, and lead. Because of the location of this pile far up slope away from the river, water quality impacts to the Animas River are probably minimal. The principal impact from this pile probably occurs during spring snowmelt. There is very little run-on from up-slope that reaches the waste pile because of the porous talus deposits above. This site should be considered a low priority for reclamation. Selected results from the leachate analysis are given below.

Protection Mine Waste Rock

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb Ppb	Zn ppb
5.39	412	2200	63	130	90	7800	250	18000

Other Sites of Interest

Riverside Mine

The draining Riverside Mine is located along the Animas River between Burrows Creek and California Gulch at an elevation of 11,500 feet. The mine site consists of an open adit and small waste pile immediately adjacent to the Animas River. This site was sampled as water quality station DM-9 and as waste rock site #24 (Figures 3 & 4). The site is located at LAT. N37°56'29.2", LONG. W107°34'56.7".

The Riverside Mine adit flowed less than 1 gpm during low-flow, and was only seeping during the high-flow. During snowmelt, prior to the high-flow sampling, water was observed to be flowing into the adit from above the site. Leachate analysis of the mine waste rock pile showed heavy metals only slightly higher than found in background materials. This site is not a significant source of metals and should be a low priority for reclamation. A diversion structure should be constructed to direct run-on water away from the mine adit. Selected results from the waste rock leachate analysis and water quality sampling are given below.

Riverside Mine Waste Rock

pH s.u.	Total Acidity mg/l	Al ppb	Cd Ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
4.3	58	69	2	37	310	160	24	330

Riverside Adit discharge

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	BDL	BDL	BDL	BDL	0.03	0.01	0.08	0.06

Columbus Group

Location
This area is located approximately ¼ to ½ mile above Animas Forks along the west side of the Animas River (Figure 36). The southernmost vein in the area is the Columbus, which was accessed at a lower elevation by the Columbus crosscut adit. The site consists of numerous adits, shafts, and stopes at elevations ranging from 11,400 feet to 11,960 feet. The waste rock piles were sampled as sites #25, #26, #27, #27A and #43 (Figure 4). The waste rock piles sampled as site #25 are believed to be on the Amethyst, July, and Eagle Chief patented mining claims. The waste pile sampled as sites #26, #27 and 27A are believed to be on the Columbus, Amethyst, and Eagle Chief patented mining claims. Waste rock sampling site #43 is believed to be on the Hermes patented mining claim. Sampling site #25 is located at LAT. N37°56'10.2", LONG. W107°34'27.6". Sampling site #26 is located at LAT. N37°56'14.0, LONG. W107°34'28.2". Sampling site #27 is located at LAT. N37°56'10.8 LONG. W107°34'20.0".". Sampling site #43 is located at LAT. N37°56'23.7 LONG. W107°34'30.7". Sample 27A was a composite sample taken along the streambank. This site was bracketed by stream sampling stations UA-4 and UA-5 (Figure 3).

Geology and Mine Workings
Mine workings at waste rock sampling site #25 include an open adit and a collapsed adit. At waste rock sampling site #26, there are two open adits and an open shaft at the entrance to the upper adit. There is an open adit, open shaft/stope and collapsed adit at waste rock sampling site #27. There is also an open, timbered , water filled shaft immediately south of the lowest adit at waste rock sampling site #27. Waste rock sampling site #43 consists of two open adits. There are also numerous collapsed prospect adits in the vicinity of this mining complex.

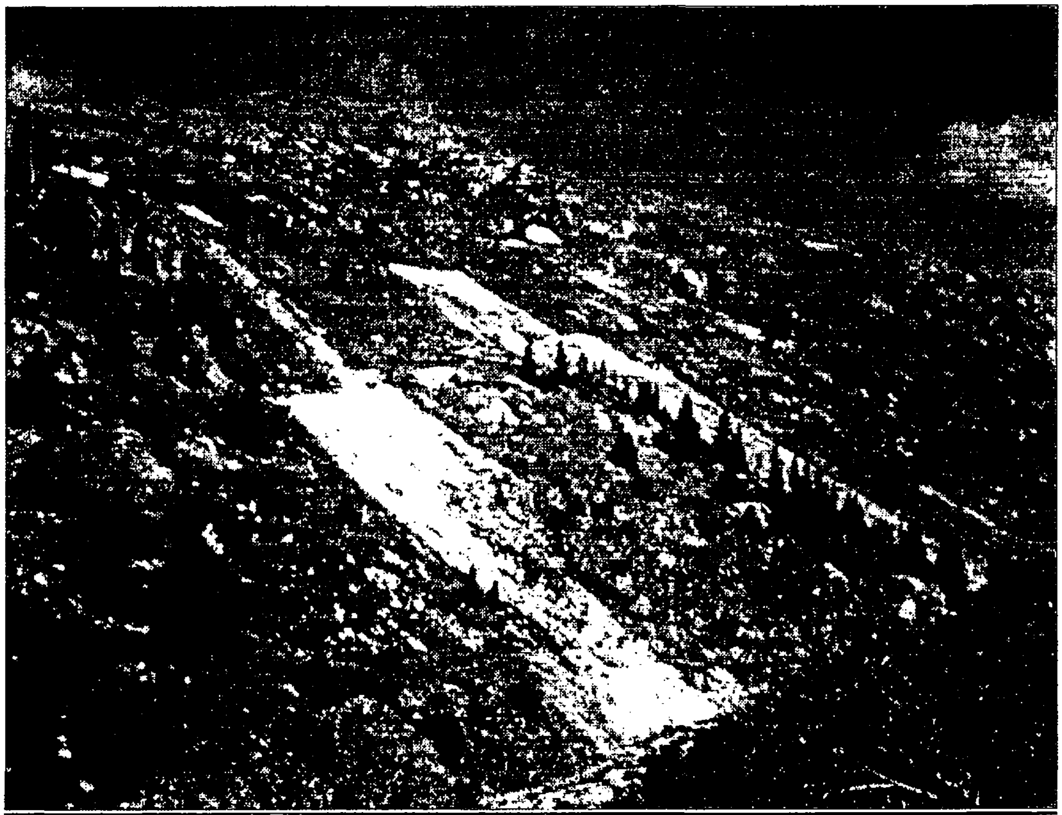

Figure 36. Columbus Mine Group Site

The Columbus mine developed a large fissure vein which trends N. 50° E. across the southeastern shoulder of Houghton Mountain, crossing the Animas River to continue on Wood Mountain as the "Yellow Rose of Texas" vein. The Columbus vein dips 65° to 70 °SE. Quartz and sulfide ores occurred in a steeply dipping gougy fracture along the vein. The ore was reported to be 8-14% combined lead and zinc, with 2 oz./ton silver. Copper content was low (King and Allsman, 1950).

The Columbus operation also worked several other veins on the steep eastern flank of Houghton Mountain, adjacent to the canyon of the Upper Animas. These include the Red Cross vein, striking northwest along the upper mountain side, dipping 70°to 78°southwest, and the western extension of the Wood Mountain Fault. The Wood Mountain structure parallels the Columbus vein, but dips more steeply southeast. Numerous other short northwest-striking veins between the principal northeast trending fissures were also mined, resulting in the plexus of workings seen on the east side Houghton Mountain above the river.

The Columbus operated principally through a 1,200 foot crosscut adit driven north from the foot of Houghton Mountain at Animas Forks, at an elevation of 11,230 feet. Drifts were turned on the numerous veins intersected by the crosscut, and much drifting, raise driving, and stoping were done. Workings on the slope of Houghton Mountain consist of drifts on the veins, some of which apparently connect with winzes or stopes farther underground. It is not certain how many of these adits connect with the main Columbus adit level underground. All development was within 500 feet of the surface, and several stopes have caved to the surface on the east side of Houghton Mountain.

Mine Wastes

The waste rock pile in this area all appeared to be similar. There is an estimated 900 cubic yards in the mine dumps at sampling site #25. There is an estimated 1,200 cubic yards in the mine dumps at sampling site #26. There is an estimated 1,100 cubic yards in the mine dumps at sampling site #27. There is an estimated 1,300 cubic yards in the mine dumps at sampling site #43. Large vegetation kill zones extend to the Animas River below these waste piles. The vegetation kill zone from pile #43 extends for approximately 100 yards to the piles at sampling site #25. All the waste piles contained yellow to light red sulfide waste. Minerals observed in the dumps included pyrite, sphalerite and galena. The waste rock at site #43 was generally coarser than found at the other sites and had correspondingly lower metals concentrations in the leachate. The waste at sampling sites #25, #26, #27, and #27A all had high zinc and lead concentrations in the leachate.

Selected results from the leachate analysis are given below.

Columbus Group Site #25

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn Ppb
3.63	*0.3*	*230*	*27*	*380*	*210*	*460*	*1500*	*4900*

Columbus Group Site #26

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn Ppb
4.18	160	85	28	240	160	110	6900	5100

Columbus Group Site #27

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn Ppb
2.53	314	280	13	260	310	420	1400	2100

Columbus Group Site #27A

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn Ppb
4.17	113	300	27	530	560	260	1800	5200

Columbus Group Site #43

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn Ppb
3.91	105	79	4	62	130	79	790	870

Historic Structures

There are no structures or equipment, other than scattered debris.

Geologic Constraints to Reclamation
This group of workings is inaccessible at present time except by foot. Their location on steep rocky slopes above the Animas River will add expense to any reclamation efforts, as access roads will have to be constructed, then later reclaimed. Snowslides and minor rockfall also affect the sites.

Water Quality Impacts
The water quality impacts from these workings occur during spring snowmelt and precipitation events. During the high-flow sampling, it was hoped that there would still be some snow melting from this site, but the slope the mine workings are on was snow-free. Nonetheless, based upon the waste rock sampling, visual evidence, and the location of the waste rock piles relative to the stream, it is evident that there are direct water quality impacts to the Animas River.

The shafts and stopes have been observed to contain snow and ice during the early part of the summer. As the snow and ice melt during the summer, this may provide a portion of the water supply for adit discharge from the Columbus Adit near Animas Forks. Also, there is visual evidence that some runoff from the slopes surrounding the mines enters the stopes and shafts.

Reclamation Options
This site should be a high priority for reclamation. Initial efforts should be to cap or backfill the shafts and stopes and divert runoff around the mine openings. As part of the safeguarding of the vertical mine openings, fly ash, lime and/or limestone should be place inside the vertical openings to provide some buffering of water entering the mine workings. The vegetation kill zones should be amended by alkaline agent addition. The waste rock piles should also be amended by injecting grout or direct alkaline amendment. It may be necessary to consolidate some of the eroded mine waste in one of the piles. This should be followed by construction of diversion ditches around the waste rock piles.

Eagle Chief Mine

Location
This mine site is located approximately one mile north of Animas Forks above the road to Engineer Pass on the east side of the Animas River Valley. The site is accessible by a short access road across from the Columbus Group of mines. The waste rock pile was sampled as site #23 (Figure 4). It is at an elevation of 11,640 feet, located at LAT. N37°56'15.1", LONG. W107°34'14.3".

Workings
This operation developed the Yellow Rose of Texas vein, which is an eastern extension of the large Columbus fissure vein in Houghton Mountain. The structure trends N. 50° E. across the southeastern shoulder of Houghton Mountain, crossing the Animas River to continue on Wood Mountain. The Yellow Rose vein dips 65° to 70 °SE. Quartz-sulfide ores occurred in a steeply dipping gougy fracture along the vein.

Mine Wastes
The waste rock pile contains approximately 1,500 cubic yards waste rock. Minerals observed in the waste rock include chalcopyrite, galena, sphalerite and rhodonite. The waste rock at this site had one of the highest concentrations of zinc, copper, manganese and lead found in the

Animas River above Eureka. There is a vegetation kill zone located below the waste rock pile. Selected results from the waste rock leachate analysis are given below.

Eagle Chief Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
3.59	861	1100	210	3200	91	16000	4700	39000

Historic Structures
This site contains a small collapsed mine office building south of the Portal Bench. A small collapsed loadout structure exists down the waste pile.

Geologic Constraints to Reclamation
This site is subject to avalanches and rock fall from the slope above.

Water Quality Impacts
Water quality impacts occur from this site during snowmelt and precipitation events. Drainage from the slope above this mine site flows directly onto the waste rock. Following precipitation events metal laden water has been observed to flow from this site onto the Engineer Pass road.

Reclamation Options
Diversion ditches should be constructed around this waste pile to reduce impacts from this site. The mine site is located far enough from the Animas River that incidental precipitation should only cause minor impacts.

Burns Gulch Mines

Location
Burns Gulch is a tributary to the Animas River. The confluence is located approximately 2 miles north of the Eureka townsite. The elevation varies between 13,860 feet at the top of Jones Mountain to 10,420 feet at the confluence with the Animas River. Two mine waste piles (#34 and #36) and one talus deposit were sampled (Figure 4). Burns Gulch was sampled above the confluence with the Animas River as site BU-1, and was bracketed in the Animas River by sites UA-8 and UA-9 (Figure 3). Sampling site #34 is believed to be on the Sioux City patented mining claim. Sampling site #36 is believed to be on the Silver Bell patented mining claim. Sampling site #36 is located at LAT. N37°54'16.6", LONG. W107°32'56.3". Sampling site #34 is located at LAT. N37°54'04.9", LONG. W107°32'47.1".

Workings
Sampling site #34 consists of 3 or 4 adits driven southwest into the walls of Burns Gulch at an elevation of 11,600 feet. All the mine adits are collapsed and share a common waste rock pile. Sampling site #36 consists of one open adit and associated waste rock pile driven southwest into the canyon wall. The adit at sampling site #36 is located at 11,430 feet.

Mine Wastes
The Sioux city waste rock pile contains an estimated 5,000 cubic yards of fine to coarse gray rock containing galena and sphalerite and some pyrite. The waste rock is located immediately below a cliff, adjacent to the stream in Burns Gulch. The waste rock is mixed with debris eroded from the adjacent cliffs. Leachate analysis of the waste rock show a high acidity and high copper, lead and zinc.

The Silver Bell waste pile contains an estimated 1,900 cubic yards of yellow to gray rock containing pyrite and calcopyrite. There is a small kill zone below the waste rock pile. Leachate testing shows that this waste rock is significantly different from the Sioux City. The waste rock is moderately high in acidity with high concentrations of iron and copper.

Selected results from the waste rock leachate analysis are given below for the Sioux City, Silver Bell, and natural talus material.

Sioux City

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
2.85	1136	410	63	940	1400	1400	5600	12000

Silver Bell

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
2.9	893	400	3	1200	4700	70	100	460

Burns Gulch Talus

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
5.29	39	36	3	17	80	110	60	230

Water Quality Impacts

The principal heavy metal of concern in Burns Gulch is zinc. At sampling site Bu-1 above the confluence with the Animas River, the measured zinc load was approximately 11 pounds per day during low-flow and 51 pounds per day during high-flow. The water quality effects from mining in Burns Gulch cannot be easily determined. There is no obvious adit discharge in Burns Gulch. There are several small adits that appear to be seeping. The stream was tested in 1993 using a Hach colorimeter in an attempt to determine the source of zinc in Burns Gulch. This testing showed that the majority of the zinc came from the northeastern fork where there is very little mining. There were springs with visible white precipitates near the bases of the waste rock piles of the Sioux City, Golconda, and Klondike mines that had high concentrations of zinc. Groundwater investigations need to be done to partition natural versus mining related zinc loads.

There are undoubtedly impacts from the waste rock piles in Burns Gulch, but the magnitude is difficult to determine. The principal impact from the waste rock pile should occur during spring snowmelt, however, zinc concentrations in Burns Gulch above the confluence with the Animas River were similar to concentrations found during high-flow, tending to indicate that the source of zinc is through groundwater inflow sources.

Reclamation Options

Because of the rugged terrain of Burns Gulch, reclamation at any of the mine sites will be very difficult. There is no readily available source of soil to cap the mine waste piles. Talus could be used to cap the mine waste pile, but capping with talus would not significantly reduce leaching during snowmelt. The best option to control impacts from the waste rock piles is to cement the piles in place by injecting grout.

Since the metals loading from the waste rock piles cannot be readily determined, it is difficult to determine what the benefits of reclamation will be. For that reason, it is currently recommended that no reclamation be done in Burns Gulch.

Treasure Mountain Mine (San Diego Tunnel)

The Treasure Mountain Mine is located on a south-facing slope in Picayune Gulch at an elevation of 11,640 feet. The mine site consists of a collapsed, draining mine adit and large waste rock pile. There are several structures at the site that are heavily visited by tourists during the summer months. The adit discharge was not sampled because the authors believed that CDPH&E had previously sampled this site and found relatively good water quality. It is estimated that the mine flows approximately 300 to 500 gpm. There is no visible staining below the mine adit. Given that the water quality of Picayune Gulch above the confluence with the Animas River is good, it would appear that this site is an insignificant source of metals. The site is located at LAT. N37°54'47.6", LONG. W107°34'07.6".

The mine waste rock pile was sampled as site #39. The waste rock pile contains approximately 9,000 cubic yards of generally fine-grained waste rock consisting principally of country rock containing some pyrite and calcite. The leachate analysis shows the waste to be high in aluminum, iron and manganese, but low in the other heavy metals. This site does not appear to be a significant source of metals to the Animas River and should be considered a low priority for reclamation. The waste rock could be used as a cover material for more reactive waste piles. Selected results from the waste rock leachate analysis are given below.

Treasure Mountain Mine Waste Rock

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
7.49	201	1300	2	14	2200	1400	260	630

Golden Fleece Mine

<u>Location</u>
This site is located near the headwaters of Picayune Gulch at an elevation of 12,320 feet. This site is believed to be in the San Juan Queen mining claim group. This site was sampled as water quality station DM-27 and as waste rock site #40 (Figures 3 & 4). The site is located at LAT. N37°54'52.5", LONG. W107°34'13.3".

<u>Geology and Mine Workings</u>
Workings in the Golden Fleece mine followed a narrow, very tight vein noted for its beautiful high-grade specimens of dendritic native gold in quartz. The vein strikes N 75° E. and dips 75°SW. It varies from a fraction of an inch to 6 inches in width, and is solid, tight, and remarkably persistent. It has been stoped over much of its extent in the upper workings of the mine.

The ore of the Golden Fleece is free gold, which occurs along the vein in dendritic branching plates embedded in a quartz, pale-pink rhodochrosite, and manganiferous calcite gangue. Very fine-grained pyrite, galena and sphalerite give the quartz associated with the free gold a dark shade.

In 1937, Treasure Mountain was explored at depth through the San Diego Tunnel of the Treasure Mountain Gold Mining Co. This 1,600 foot crosscut was driven from an altitude of 11,650 in Picayune Gulch to explore the ground beneath the upper workings of the Golden Fleece and Scotia mines. The adit heads N. 55 °W to a position about 1,000 feet below the Golden Fleece workings. Over 700 feet of drifting southwest parallel to the Scotia vein was conducted, and the attempt to locate extensions of the gold-quartz vein at depth included crosscutting and diamond drilling work. By 1948, nothing economic had been defined.

Mine Wastes

The waste rock piles contains approximately 6,500 cubic yards of pyritic waste rock with visible sphalerite. The waste rock had low acidity, but there is a kill zone located below the waste rock pile at the draining mine adit. Metals concentrations in the leachate show that the waste is high in aluminum and iron, but below the average of all the waste rock piles in the Upper Animas River. Selected results from the waste rock leachate analysis are given below.

Golden Fleece Mine

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
2.88	101.4	2600	5	87	4500	12	BDL	1100

Historic Structures

There are no structures or equipment, other than scattered debris.

Water Quality Impacts

The Golden Fleece adit discharge is located near the ridge top over ¼ mile from the receiving stream. The mine drains approximately 4 to 10 gpm of pH 3.5-3.8 metal laden water. There is considerable iron staining along the flow path of the mine drainage. The adit discharge has been diverted away from the waste rock pile except for a portion of the toe of the pile. The zinc, iron and aluminum concentrations in the drainage are high, but due to the relatively low flow, the metals load is relatively low. Compared to all the adit discharges in the Upper Animas River, this adit discharge produced 0.66-1.79% of the dissolved heavy metals. Because of the distance between the adit discharge and the stream, the impacts from the adit discharge are probably localized. Most of the metals are probably removed by natural processes as the water flows through the relatively calcite rich unconsolidated materials in Picayune Gulch. The measured metal loadings from this mine are given below.

Golden Fleece Mine

Flow Regime	Diss. Al g/day	Diss. As g/day	Diss. Cd g/day	Diss. Cu g/day	Diss. Fe g/day	Diss. Pb g/day	Diss. Mn g/day	Diss. Zn g/day
Low-Flow	34.95	BDL	0.15	0.80	25.04	1.34	136.13	24.61
High-Flow	127.0	BDL	0.2	2.3	219.3	1.1	263.9	26.3

Reclamation Options

This site should be a low priority for reclamation. Reclamation of this site will do very little to improve the water quality of the Animas River. Picayune Gulch above the Animas River is an insignificant source of heavy metals. An anoxic limestone drain can be constructed in the adit, and a small settling pond can be built outside the adit. The mine drainage flow path should be revegetated by alkaline addition. If an anoxic limestone drain and settling pond are constructed, the flow path should be changed to avoid contact with the waste rock pile. Run-on diversion should also be constructed to route overland flow away from the waste rock.

Unknown Prospect in Picayune Gulch

This site consists of a collapsed adit and small waste rock pile near the headwaters of Picayune Gulch at an elevation of 11,960 feet. The mine is located at LAT. N37°56'45.8", LONG. W107°34'33.8". The waste rock was sampled as site #41 (Figure 4).

This site was sampled because the waste rock pile is in the stream channel and a portion of the stream-flow was passing through the waste pile. The waste rock contains approximately 1,000 cubic yards of fine-grained fault gouge. Leachate analysis shows that the metals in the waste rock are at similar concentrations as the background materials. This site is not a significant source of metals to the Animas River. The waste rock could be used as a capping material for waste piles in the vicinity. Selected results of the leachate analysis are given below.

Unknown Mine Waste Rock

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
4.52	52	35	BDL	5	55	87	BDL	23

Unknown Mine Near Picayune Gulch

This mine is located on the east side of the Animas River near the confluence with Picayune Gulch and across the river from the Toltec Mine. The mine site consists of an open adit and waste pile at an elevation of 10,600 feet. The waste rock pile was sampled as site #31 (Figure 4). The mine site is located at LAT. N37°54'39.5", LONG. W107°33'17.6".

The waste rock pile contains approximately 1,400 cubic yards. The waste rock pile is located immediately adjacent to the Animas River. Leachate analysis of the waste rock indicates that this site is an insignificant source of metals to the Animas River. Results from the leachate analysis are given below.

Unknown Mine Near Picayune Gulch

pH s.u.	Total Acidity mg/l	Al ppb	Cd ppb	Cu ppb	Fe ppb	Mn ppb	Pb ppb	Zn ppb
5.39	412	2200	63	130	90	7800	250	18000

RECOMMENDATIONS FOR FURTHER INVESTIGATIONS

This investigation focused only on metals contributions from surface mine waste and mine portal discharges in the Upper Animas River watershed. Mining-related and natural groundwater loading sources were not investigated, and have not, as yet, been quantified. Groundwater flow from the mines currently provides an unquantified pathway for contamination to enter the streams. Data on groundwater qualities and quantities is essential to understanding the hydrologic system and metals migration in the Upper Animas River watershed. It is highly recommended that monitoring wells be placed in and near some of the mines exhibiting likely interactions with the groundwater system, to collect this data. A few of the mines in this category include the Red Cloud complex, Lucky Jack, Ben Butler, Columbus, Vermillion, and Silver Queen/ Sound Democrat site.

Several unanswered questions also remain about some of the mining sites investigated. These issues were discussed in the narrative for each individual site in this report. In most cases, the unanswered question must be investigated prior to a final decision on the best reclamation option. In many cases, the answer to the question may simply involve a water sample, while in other cases, it may take additional work to better understand the site hydrology. For reference, these questions are consolidated and reviewed below.

<u>Lucky Jack Mine</u> – The mine adit should be decanted to allow investigation of the mine workings. The workings may intercept flow from the adjacent drainage. If there are discrete in-flows, testing should be done to determine the sources of heavy metals through mass-loading analysis. If the in-flows are relatively clean, the water can be piped to the adit before it becomes contaminated, or the fractures can be grouted to eliminate the inflow source.

<u>Little Chief Mine</u> – This adit discharge could not be sampled during high-flow due to snow completely covering the adit. A high-flow sample should be collected. A suitable marker should be set so the mine adit can be located when still covered by snow. Part of the adit discharge is believed to flow through the waste rock pile. The blockage at the adit should be removed to allow for free-flow of water from the adit away from the waste pile.

<u>London Mine</u> – There are a series of springs along the base of the waste rock pile. The source of these springs should be investigated. Groundwater monitoring wells may have to be drilled to determine the source, or a tracer can be added to the mine pool to determine if mine drainage is flowing through fracture systems.

<u>Mountain Queen Mine</u> - The mine workings should be investigated to determine if there are any discrete in-flows, or if mine workings may intercept flow from the adjacent drainage. If there are discrete in-flows, testing should be done to determine the sources of heavy metals through mass-loading analysis. If the in-flows are relatively clean, the water can be piped to the adit before it becomes contaminated or the fractures can be grouted to eliminate the source.

<u>Burrows Mine</u> – A portion of the mine drainage is believed to be flowing through the unconsolidated material at the entrance or through fractures near the mine entrance of both adits at this site. A bulkhead or partial bulkhead should be constructed inside the adit to collect the flow so an accurate flow measurement and loading calculation can be made.

Vermillion Mine – Because of the relative inaccessibility of this mine site, the workings should be investigated to determine if there are any discrete in-flows. The mine workings may intercept flow from the adjacent drainage or collapsed stopes. If there are discreet in-flows, testing should be done to determine the sources of heavy metals through mass-loading analysis. If the in-flows are relatively clean, the water can be piped to the adit before it becomes contaminated or the fractures can be grouted to eliminate the source.

Vermillion Tunnel – Water quality samples should be collected at the adit and below the waste rock pile to determine if any metals are leached from the waste rock as the adit discharge passes through. The workings should be investigated to determine if there are any discrete in-flows, as they may intercept flow from the adjacent drainage or collapsed stopes.

Bagley Tunnel - The mine workings should be investigated to map out in-flows. It is highly probable that clean inflows are intercepted in the mile-long tunnel, and then become contaminated by the effluent draining from the mined ore bodies. A loading analysis can then be done to identify and segregate clean versus contaminated water inflows. Clean water can be piped to the creek before it becomes contaminated, or the fractures can be grouted to eliminate the inflow source. Mined veins might also be pre-treated to help prevent ARD formation.

Silver Queen Mine – A collapsed structure makes flow measurement at this site difficult. A portion of the flow from the adit appeared to be infiltrating the surrounding waste rock material as it exited the mine adit. The blockage at the mine entrance should be removed so an accurate flow measurement and loading analysis can be made.

Sound Democrat Mine – The measured flow from this mine increases greatly during spring snowmelt. The increase in flow is probably due to interception of flow from a small ephemeral stream or pond. The mine workings should be investigated to determine if there are any discreet in-flows. The mine workings may intercept flow from the adjacent drainage. If there are discreet in-flows, testing should be done to determine the sources of heavy metals through mass-loading analysis. If the in-flows are relatively clean, the water can be piped to the adit before it becomes contaminated or the fractures can be grouted to eliminate the source. The adit entrance will have to be clean out to allow safe access.

Red Cloud Group
A tracer should be used to determine if the shafts and mine workings are in hydraulic connection with the Bagley Tunnel discharge.

Columbus Group – A tracer should be used to determine if the snow and ice in the stopes and shafts are part of the source of adit discharge from the Columbus Mine.

Treasure Mountain Mine – A water sample should be collected at the Treasure Mountain Mine to determine the metals loading from this mine.

ANALYSIS OF RESULTS

Both natural and mining related metals loading affect water quality in the Upper Animas River. This investigation was designed to quantify the relative contribution of surface mine waste and mine portal discharge sources to the Upper Animas River. A simple model was used to provide some indication of the potential water quality improvement which might be expected if surface wastes and portal discharges were addressed.

To do this, dissolved manganese was selected as the parameter to be used to determine the relative percentage of metals loading that can be attributed to adit discharges. Manganese was chosen because it is found in all the adit discharges in the Upper Animas River, because there is a high correlation between manganese and other heavy metals of concern, and because it is a "conservative" metal, meaning that it is not readily precipitated. The assumption is that measured dissolved manganese load from the adit discharges will be approximately equal to the dissolved manganese load measured in the stream below the sources, <u>if</u> there are no natural manganese sources or inflows of mining impacted groundwater. For example, between water quality stations UA-5 and UA-6, where there is only a small inflow from an undisturbed area, the dissolved manganese load, during low-flow, increased by 2%. In contrast, dissolved iron, which is an example of a "non-conservative" metal, decreased 40% in the same stream segment. This shows that iron is precipitating in the stream channel.

The relative metal contributions from adit discharge sources were investigated in the Upper Animas River at water quality station UA-7 near Animas Forks. This station was chosen because the majority of the metals loading to the Upper Animas River occurs above this point. Also, there was considerable in-stream precipitation of manganese and other metals below this station. The measured low-flow manganese load at UA-7 was approximately 89 pounds per day and decreased to approximately 57 pounds per day at station UA-12 in the Eureka Townsite. At station UA-7, the upstream adit discharges can account for about 11 lb/day, or about 13% of the dissolved manganese load. The high-flow manganese load at station UA-7 was 661 lb/ day. The adit discharges upstream of UA-7 can account for a maximum of about 17 lb/day, or about 3% of the dissolved manganese load at high-flow. This suggests that the adit discharges above Animas Forks contribute a maximum of only 3 to 13% of the dissolved heavy metals found in the stream.

Quantification of heavy metals contribution by the surface mine waste is difficult. In general, surface mine waste contributes heavy metals to surface water during spring snowmelt and during storms. The leachate data collected on selected waste materials in the Upper Animas River indicates that about one to two orders of magnitude <u>more</u> heavy metals are available for leaching in the mining waste than in native rock and soil materials. There are approximately 700 mine features shown on the USGS Quadrangle map. If we assume that the average disturbance at a mining site is 0.05 acres (45' x 45'), the mining sites make up approximately 0.3% of the planar surface area. If one to two orders of magnitude (10 to 100 times) more metals are leached from the mining site, this would mean that 3 to 30% (0.3% X 10 or 100) of the metals loading during snowmelt and precipitation events comes from the mining wastes. The lower percentage is probably most appropriate, since the majority of the mining sites are far away from the nearest receiving stream, snowmelt occurs at different times in different areas depending upon the elevation and aspect, and only a portion of the runoff enters the stream. In many areas the heavy metals are attenuated by natural processes, particularly where there are only a few, small mining sites. In some areas such as Burrows Creek, where there is a high concentration of mining features, the heavy metals contribution from mine waste piles may approach the 30% level.

Adding the estimated contribution from mine waste piles to the loading percentage from adit discharge sources, the estimated contribution to metals loading from these sources is 13% during low-flow, and 6% during high-flow. Assuming that there are 92 days of high-flow and 173 days of low-flow, the annualized percentage would be 11%.

If the reclamation activities described in this report for each site were completed, the reduction in loading from the individual sites would vary, but might average about 80%. Therefore, if all the reclamation activities described in this report were completed, the overall in-stream metals loading reduction would be about 9%. Additional reduction of metals due to geochemical processes in the stream would further reduce the loading at the Eureka Townsite.

CONCLUSIONS

Based upon the analysis of data collected during this investigation, the following conclusions can be made:

1. The majority of the aluminum and zinc loading in Burrows Creek and California Gulch comes from unquantified groundwater inflow sources.

2. Dissolved copper concentrations are generally above acute aquatic toxicity limits in Burrows Creek, California Gulch, Burns Gulch, and Placer Gulch. The principal source of the copper throughout the basin appears to be from unquantified groundwater inflow sources.

3. Dissolved zinc concentrations are generally above acute aquatic toxicity limits above Animas Forks, and above chronic toxicity limits from the Eureka Townsite to Animas Forks.

4. The adit discharge sources and mine waste piles in the Upper Animas River contribute an estimated 6 to 13% of the heavy metals in the Upper Animas River above Animas Forks. The remaining in-stream load is a combination of natural background inflows, other anthropomorphic inflows such as run-off from roads and over-grazed areas, and mining-related contaminated groundwater inflows. Groundwater characterization needs to be done before the remaining unquantified loading sources can be further partitioned.

5. The estimated annualized heavy metals contribution from adit discharges and surface mine waste in the Upper Animas River is 11%. If the reclamation activities described in this report for each site were completed, the reduction in loading from the individual sites would vary, but would probably average about 80%. Therefore, if all the reclamation activities described in this report were completed, the overall in-stream metals loading reduction would be about 9%. Additional reduction of metals due to geochemical processes in the stream would further reduce the loading measured at the Eureka Townsite.

6. Even if all surface mine waste and adit discharge impacts are mitigated, the water quality of California Gulch and Burrows Creek would remain too poor to support aquatic life. It is also unlikely that the Upper Animas River between the Eureka Townsite and Burrows Creek would be able to support aquatic life.

7. Reclamation of the adit discharge and surface mine waste sources in the Upper Animas River watershed is an important first step in accomplishing the goal of improving water quality in the Animas River below Silverton. Due to the high percentage of remaining metals loading from unquantified groundwater inflow sources in this drainage, reclamation work in the other watersheds in the Animas River Basin must also be conducted.

8. Table 2 is a brief synopsis of the reclamation recommended at this time at each of the sites discussed in this report. Detailed discussion of these recommended actions is provided in the text.

Table 2. Summary of Reclamation Actions Recommended at This Time

Site	Recommended Action		
	Adit discharge Reclamation	**Waste Rock Reclamation**	**No Action at this time**
HEADWATERS AND BURROWS CREEK SITES			
Unknown Prospect North of Denver Lake			X
Lucky Jack Mine	X	X	
Little Chief Mine			X
Early Bird Crosscut			X
London Mine	X	X	
Ben Butler		X	
Prairie Mine			X
Red Cloud Area			X
Unknown Prospect in Lower Burrows Creek			X
CALIFORNIA GULCH SITES			
Mountain Queen Mine	X	X	
Indian Chief Mine		X	
Little Ida Mine		X	
Burrows Mine	X	X	
Vermillion Mine	X	X	
Vermillion Tunnel			X
Bagley Tunnel	X	X	
Columbus Mine	X	X	
PLACER GULCH SITES			
Silver Queen Mine	X		
Sound Democrat Mine	X		
ANIMAS RIVER SITES			
Unknown Mine South of Grouse Gulch			X
Toltec Mine			X
Silver Wing Mine	X	X	
Tom Moore Mine		X	
Senator Mine			X
Mill Tailings North of Grouse Gulch		X	
Protection Mine			X
OTHER SITES OF INTEREST			
Riverside Mine			X
Columbus Group		X	
Eagle Chief		X	
Burns Gulch Mines			X
Treasure Mountain Mine			X
Golden Fleece Mine			X
Unknown Prospect in Picayune Gulch			X
Unknown Mine across from Toltec			X

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APPENDIX 1

Upper Animas River Low-Flow
Raw Data

Site #	Description	Flow	pH	Cond.	Temp.	Tot. As	Diss. As	Tot. Cd	Diss. Cd	Tot. Pb	Diss. Pb	Tot. Se	Diss. Se
		cfs	s.u.	umhos/cm	Deg C	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
UA-1	Animas above Denver Lake	0.067	7.34	79.8	11	4.00	BDL	BDL	BDL	1.2	BDL	BDL	BDL
UA-2	Animas above Lucky Jack Mine	0.029	7.6	69.7	9	1.9	BDL	0.9	0.9	1.1	BDL	BDL	BDL
UA-3	Animas above Horseshoe Creek	0.926	6.89	80	13	BDL	BDL	0.6	0.6	BDL	BDL	BDL	BDL
UA-4	Animas below Burrows Creek	2.568	5.2	100.2	10	BDL	BDL	5.6	6.4	1.7	1.5	BDL	BDL
UA-5	Animas below mining complex	1.957	6.01	96.4	12	BDL	BDL	5.0	5.9	9.8	7.7	BDL	BDL
UA-6	Animas above California Gulch	2.446	5.7	73	10	BDL	BDL	4.5	5.1	8.5	5.2	BDL	BDL
UA-7	Animas below California Gulch	5.512	5.95	178	9	BDL	BDL	4.8	5.5	13.00	3.1	BDL	BDL
UA-8	Animas above Burns Gulch	11.188	7.42	183	11	BDL	BDL	2.2	2.6	5.9	BDL	BDL	BDL
UA-9	Animas below Burns Gulch	14.387	6.33	153	8	BDL	BDL	2.2	3.00	5.9	0.9	BDL	BDL
UA-10	Animas below Silver Wing Mine	14.467	7.07	167	8	BDL	BDL	2.7	3.1	4.9	BDL	BDL	BDL
UA-11	Animas above Niagra Gulch	15.115	6.86	171	11	BDL	BDL	2.3	2.7	4.9	BDL	BDL	BDL
UA-12	Animas above Eureka Gulch	14.094	7.02	184	11	BDL	BDL	2.2	2.8	5.00	BDL	BDL	BDL
CG-2	California Gulch below Mtn. Queen	0.818	6.61	273	7	BDL	BDL	0.9	1.2	1.3	BDL	BDL	BDL
CG-3	Cal Gulch above DM-11-16	1.137	4.61	299	8	BDL	BDL	6.1	8.00	1.4	BDL	BDL	BDL
CG-4	Cal Gulch below DM-11-16	2.099	6.17	235	11	BDL	BDL	4.4	3.9	0.9	BDL	BDL	BDL
CG-5	Tributary below DM-17	0.031	3.69	643	8	BDL	BDL	21.5	21.3	302	276	BDL	BDL
CG-6	Cal Gulch below DM-17 tributary	2.572	4.96	177	9	BDL	BDL	4.8	6.00	1.1	BDL	BDL	BDL
CG-7	Cal Gulch above Placer Gulch	2.524	6.62	247	10	BDL	BDL	5.2	5.7	8.5	BDL	BDL	BDL
CG-8	Cal Gulch below Placer Gulch	4.224	5.64	197	10	BDL	BDL	3.9	4.5	53.3	4.4	BDL	BDL
CG-9	Cal Gulch below Bagley Mine Drainage	5.26	6.46	207	10	BDL	BDL	4.3	5.00	24.9	2.9	BDL	BDL
CG-10	Cal Gulch below Bagley Mill Tailings	5.145	6.32	205	9	BDL	BDL	4.3	5.1	20.00	2.6	BDL	BDL
CG-11	Cal Gulch above Columbus Mine	4.195	5.6	211	9	BDL	BDL	4.2	4.9	15.4	1.8	BDL	BDL
CG-12	Cal Gulch above Animas Confluence	4.212	5.58	209	9	BDL	BDL	4.6	3.8	15.9	2.7	BDL	BDL
BG-1	Burrows Creek above Trans-Basin Diversion	0.268	4.38	155	ND	BDL	BDL	11.6	12.9	16.00	15.6	BDL	BDL
BG-2	Burrows Creek above London Mine	0.234	4.59	128	11	BDL	BDL	11.2	12.2	11.7	11.6	BDL	BDL
BG-3	Burrows Creek below London Mine	0.756	4.63	191	10	BDL	BDL	20.00	17.7	6.00	5.9	BDL	BDL
BG-4	Burrows Creek above Large Fault	0.788	4.49	158	10	BDL	BDL	14.5	15.2	5.2	5.3	BDL	BDL
BG-5	Burrows Creek above Animas	0.579	4.88	160.2	10	BDL	BDL	14.00	15.4	5.00	5.00	BDL	BDL
LJ-1	Animas below Lucky Jack Mine	0.03	6.96	98	11	BDL	BDL	5.5	5.1	BDL	BDL	BDL	BDL
HC-1	Horseshoe Creek	0.954	6.9	76	9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
PL-1	Placer Gulch	1.605	5.45	114	9.6	BDL	BDL	2.1	2.7	88.4	8.8	BDL	BDL
CN-1	Cinnamon Creek	1.832	6.58	141	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GG-1	Grouse Gulch	1.309	6.53	170	11	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
PY-1	Picayune Gulch	2.256	6.59	287	13	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BU-1	Burns Gulch	3.645	7.66	127	12	BDL	BDL	3.4	3.00	3.3	2.7	BDL	BDL
NG-1	Niagra Gulch	1.693	7.45	151	11	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Upper Animas River Low-Flow
Raw Data

Site #	Description	Flow cfs	pH s.u.	Cond. umhos/cm	Temp. Deg C	Tot. As ug/l	Diss. As ug/l	Tot. Cd ug/l	Diss. Cd ug/l	Tot. Pb ug/l	Diss. Pb ug/l	Tot. Se ug/l	Diss. Se ug/l
DM-1	Unknown Prospect Above Denver Lake	0.0003	3.81	286	11	BDL	BDL	33.00	38.8	324	375	BDL	BDL
DM-2	Lucky Jack Mine Drainage	0.101	5.07	81	12	1.9	BDL	3.3	3.8	271	230	BDL	BDL
DM-3	Little Chief Mine Drainage	0.005	3.53	331	8	BDL	BDL	36.1	25.5	7.2	4.5	BDL	BDL
DM-4	Early Bird Mine Drainage	0.0003	3.6	378	11	BDL	BDL	18.9	19.00	88.4	77.7	BDL	BDL
DM-5	Draining Mine near London Mine-West	0.0003	6.38	67	11	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-6	Draining Mine near London Mine-East	0.0003	6.29	642		BDL	BDL	28.3	26.4	133.6	119.3	BDL	BDL
DM-7	London Mine Drainage	0.002	6.26	457	8	21.6	3.1		64	55.6	BDL	BDL	BDL
DM-8	Prairie Mine Drainage	0.001	6.93	272	8	BDL	BDL	4.00	4.5	2.00	BDL	BDL	BDL
DM-9	Riverside Mine Drainage	0.0003	7.07	80	11	BDL	BDL	BDL	BDL	16.2	12.9	BDL	BDL
DM-10	Mountain Queen Adit Drainage	0.005	3.66	313	7	3.5	3.6		62	160.1	135.8	BDL	BDL
DM-14	Little Idam Mine Drainage - Lower Adit	0.004	7.2	99	6	BDL	BDL	3.5	3.9	42.2	36.2	BDL	BDL
DM-15	Burrows Mine Drainage - West	0.002	5.66	120	7	BDL	BDL	25.1	23.9	505	543	BDL	BDL
DM-16	Burrows Mine Drainage - East	0.003	5.41	167	8	BDL	BDL	19.7	20.00	4.6	BDL	BDL	BDL
DM-17	Vermillion Mine Drainage	0.016	3.09	996	8	16.2	20.0	ND	211	ND	1611	BDL	BDL
DM-18	Vermillion Tunnel Mine Drainage	0.24	6.33	574	9	1.6	1.2	2.8	3.3	3.1	1.1	BDL	BDL
DM-19	Bagley Tunnel Drainage	0.15	6.42	650	12	1.7	BDL	10.8	11.2	1.1	BDL	BDL	BDL
DM-20	Columbus Mine Drainage	0.003	3.28	1626	8	24.7	28.1	ND	1037	ND	353	BDL	BDL
DM-21	Silver Wing Mine Drainage	0.037	6.52	381	13	15.1	3.9	13.8	14.6	7.7	BDL	BDL	BDL
DM-22	Tom Moore Mine Drainage	0.072	7.32	348	11	BDL	BDL	2.4	2.00	1.1	BDL	BDL	BDL
DM-24	Senator Mine Drainage	0.163	6.59	1203	14	2.1	1.4	4.00	3.9	24.4	6.8	BDL	BDL
DM-25	Silver Queen Mine Drainage	0.0007	3.25	680	7	2.1	1.7	29.7	28.1	335	355	BDL	BDL
DM-26	Sound Democrat Mine Drainage	0.008	3.74	480	8	BDL	BDL	24.8	22.4	168.2	150.4	BDL	BDL
DM-27	Golden Fleece Mine Drainage	0.008	3.8	217	11	BDL	BDL	8.2	7.8	73.8	68.6	BDL	BDL
DM-28	Indian Chief Mine Drainage	0.004	6.78	179	7	7.6	6.00	1.1	1.00	38.4	22.6	BDL	BDL
DM-29	Toltec Mine Drainage	0.0015	8.08	342	11	7.3	2.9	1.00	BDL	22.3	BDL	BDL	BDL
DM-30	Unknown Mine South of Grouse Gulch	0.0013	7.49	233	11	BDL	BDL	BDL	BDL	1.7	BDL	BDL	BDL
DM-31	Unknown Prospect in Lower Burrows Creek	0.0022	5.86	103	11	BDL	BDL	2.6	2.7	11.00	3.2	BDL	BDL

Upper Animas River Low-Flow
Raw Data

Site #	Description	Tot. Ag	Diss. Ag	Tot. Th	Diss. Th	Tot. Al	Diss. Al	Tot. Sb	Diss. Sb	Tot. Ba	Diss. Ba	Tot. Be	Diss. Be
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
UA-1	Animas above Denver Lake	BDL	BDL	BDL	BDL	239	BDL	BDL	BDL	13	11	BDL	BDL
UA-2	Animas above Lucky Jack Mine	BDL	BDL	BDL	BDL	46	BDL	BDL	BDL	8	7	BDL	BDL
UA-3	Animas above Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8	7	BDL	BDL
UA-4	Animas below Burrows Creek	BDL	BDL	BDL	BDL	1899	473	BDL	BDL	13	13	1	1
UA-5	Animas below mining complex	BDL	BDL	BDL	BDL	1323	103	BDL	BDL	14	13	1	1
UA-6	Animas above California Gulch	BDL	BDL	BDL	BDL	997	BDL	BDL	BDL	14	13	1	BDL
UA-7	Animas below California Gulch	BDL	BDL	BDL	BDL	1415	107	BDL	BDL	15	15	2	1
UA-8	Animas above Burns Gulch	BDL	BDL	BDL	BDL	497	40	BDL	BDL	14	15	1	BDL
UA-9	Animas below Burns Gulch	BDL	BDL	BDL	BDL	414	41	BDL	BDL	13	12	1	BDL
UA-10	Animas below Silver Wing Mine	BDL	BDL	BDL	BDL	413	BDL	BDL	BDL	13	13	1	BDL
UA-11	Animas above Niagra Gulch	BDL	BDL	BDL	BDL	295	42	BDL	BDL	12	12	BDL	BDL
UA-12	Animas above Eureka Gulch	BDL	BDL	BDL	BDL	319	BDL	BDL	BDL	12	12	1	BDL
CG-2	California Gulch below Mtn. Queen	BDL	BDL	BDL	BDL	1250	315	BDL	BDL	26	26	3	3
CG-3	Cal Gulch above DM-11-16	BDL	BDL	BDL	BDL	5055	3581	BDL	BDL	21	19	9	7
CG-4	Cal Gulch below DM-11-16	BDL	BDL	BDL	BDL	4095	2387	BDL	BDL	16	16	7	5
CG-5	Tributary below DM-17	BDL	BDL	BDL	BDL	2743	2702	BDL	BDL	19	18	1	1
CG-6	Cal Gulch below DM-17 tributary	BDL	BDL	BDL	BDL	4251	2094	BDL	BDL	16	15	7	5
CG-7	Cal Gulch above Placer Gulch	BDL	BDL	BDL	BDL	4675	728	BDL	BDL	17	15	7	4
CG-8	Cal Gulch below Placer Gulch	0.2	BDL	BDL	BDL	2683	441	BDL	BDL	18	16	4	2
CG-9	Cal Gulch below Bagley Mine Drainage	BDL	BDL	BDL	BDL	1872	287	BDL	BDL	16	15	3	2
CG-10	Cal Gulch below Bagley Mill Tailings	BDL	BDL	BDL	BDL	1833	280	BDL	BDL	17	16	3	2
CG-11	Cal Gulch above Columbus Mine	BDL	BDL	BDL	BDL	1620	205	BDL	BDL	16	16	3	2
CG-12	Cal Gulch above Animas Confluence	BDL	BDL	BDL	BDL	1637	220	BDL	BDL	16	16	3	2
BG-1	Burrows Creek above Trans-Basin Diversion	0.2	BDL	BDL	BDL	7005	6840	BDL	BDL	18	17	1	1
BG-2	Burrows Creek above London Mine	BDL	BDL	BDL	BDL	3378	3474	BDL	BDL	32	32	1	1
BG-3	Burrows Creek below London Mine	BDL	BDL	BDL	BDL	6509	6650	BDL	BDL	24	24	3	3
BG-4	Burrows Creek above Large Fault	BDL	BDL	BDL	BDL	5651	5695	BDL	BDL	22	21	2	3
BG-5	Burrows Creek above Animas	BDL	BDL	BDL	BDL	5360	5517	BDL	BDL	21	21	2	3
LJ-1	Animas below Lucky Jack Mine	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	18	18	BDL	BDL
HC-1	Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6	7	BDL	BDL
PL-1	Placer Gulch	0.4	BDL	BDL	BDL	1143	BDL	BDL	BDL	20	17	1	1
CN-1	Cinnamon Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8	8	BDL	BDL
GG-1	Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10	12	BDL	BDL
PY-1	Picayune Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	33	33	BDL	BDL
BU-1	Burns Gulch	BDL	BDL	BDL	BDL	BDL	47	BDL	BDL	8	8	BDL	BDL
NG-1	Niagra Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4	5	BDL	BDL

Upper Animas River Low-Flow
Raw Data

Site #	Description	Tot. Ag ug/l	Diss. Ag ug/l	Tot. Th ug/l	Diss. Th ug/l	Tot. Al ug/l	Diss. Al ug/l	Tot. Sb ug/l	Diss. Sb ug/l	Tot. Ba ug/l	Diss. Ba ug/l	Tot. Be ug/l	Diss. Be ug/l
DM-1	Unknown Prospect Above Denver Lake	0.2	BDL	BDL	BDL	659	740	BDL	BDL	9	11	1	1
DM-2	Lucky Jack Mine Drainage	BDL	BDL	BDL	BDL	307	261	BDL	BDL	22	20	BDL	BDL
DM-3	Little Chief Mine Drainage	0.4	0.3	BDL	BDL	10520	7738	BDL	BDL	7	5	2	2
DM-4	Early Bird Mine Drainage	0.5	0.3	BDL	BDL	5994	6119	BDL	BDL	13	10	3	3
DM-5	Draining Mine near London Mine-West	0.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12	12	BDL	BDL
DM-6	Draining Mine near London Mine-East	0.4	0.2	BDL	BDL	419	441	BDL	BDL	16	11	1	1
DM-7	London Mine Drainage	BDL	BDL	BDL	BDL	924	BDL	BDL	BDL	9	9	1	1
DM-8	Prairie Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11	12	BDL	BDL
DM-9	Riverside Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	14	13	BDL	BDL
DM-10	Mountain Queen Adit Drainage	0.7	0.7	BDL	BDL	3890	4028	BDL	BDL	17	19	2	2
DM-14	Little Idam Mine Drainage - Lower Adit	BDL	BDL	BDL	BDL	195	97	BDL	BDL	2	2	BDL	BDL
DM-15	Burrows Mine Drainage - West	0.2	BDL	BDL	BDL	566	503	BDL	BDL	30	31	1	1
DM-16	Burrows Mine Drainage - East	BDL	BDL	BDL	BDL	464	40	BDL	BDL	9	8	1	1
DM-17	Vermillion Mine Drainage	1.2	1.1	BDL	BDL	3091	3079	BDL	BDL	6	4	2	2
DM-18	Vermillion Tunnel Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	19	18	BDL	1
DM-19	Bagley Tunnel Drainage	BDL	BDL	BDL	BDL	80	135	BDL	BDL	12	11	1	1
DM-20	Columbus Mine Drainage	0.2	BDL	BDL	BDL	18650	18870	BDL	BDL	5	5	6	6
DM-21	Silver Wing Mine Drainage	BDL	BDL	BDL	BDL	872	408	BDL	BDL	22	21	2	2
DM-22	Tom Moore Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6	6	BDL	1
DM-24	Senator Mine Drainage	BDL	BDL	BDL	BDL	1741	1675	BDL	BDL	11	12	6	6
DM-25	Silver Queen Mine Drainage	0.8	0.6	BDL	BDL	1407	1365	BDL	BDL	9	10	5	5
DM-26	Sound Democrat Mine Drainage	0.2	0.2	BDL	BDL	1456	1524	BDL	BDL	6	7	2	3
DM-27	Golden Fleece Mine Drainage	0.4	0.5	BDL	BDL	1717	1785	BDL	BDL	12	12	1	2
DM-28	Indian Chief Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12	12	BDL	BDL
DM-29	Toltec Mine Drainage	BDL	BDL	BDL	BDL	209	BDL	BDL	BDL	24	14	BDL	BDL
DM-30	Unknown Mine South of Grouse Gulch	BDL	BDL	BDL	BDL	108	BDL	BDL	BDL	11	10	BDL	BDL
DM-31	Unknown Prospect in Lower Burrows Creek	BDL	BDL	BDL	BDL	67	BDL	BDL	BDL	13	12	BDL	BDL

Upper Animas River Low-Flow
Raw Data

Site #	Description	Tot. Cr	Diss. Cr	Tot. Co	Diss. Co	Tot. Cu	Diss. Cu	Tot. Fe	Diss. Fe	Tot. Mn	Diss. Mn	Tot. Ni	Diss. Ni
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
UA-1	Animas above Denver Lake	BDL	BDL	BDL	BDL	BDL	4	628	174	80	60	BDL	BDL
UA-2	Animas above Lucky Jack Mine	BDL	BDL	BDL	BDL	BDL	BDL	50	BDL	2	1	BDL	BDL
UA-3	Animas above Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	19	6	8	8	BDL	BDL
UA-4	Animas below Burrows Creek	BDL	BDL	BDL	BDL	24	20	44	23	999	956	BDL	BDL
UA-5	Animas below mining complex	BDL	BDL	BDL	BDL	20	16	41	18	746	722	BDL	BDL
UA-6	Animas above California Gulch	BDL	BDL	BDL	BDL	16	10	32	6	614	590	BDL	BDL
UA-7	Animas below California Gulch	BDL	BDL	BDL	BDL	22	10	158	56	3052	2997	BDL	BDL
UA-8	Animas above Burns Gulch	BDL	BDL	BDL	BDL	6	BDL	65	BDL	1262	1251	BDL	BDL
UA-9	Animas below Burns Gulch	BDL	BDL	BDL	BDL	11	4	58	BDL	986	947	BDL	BDL
UA-10	Animas below Silver Wing Mine	BDL	BDL	BDL	BDL	27	12	71	BDL	995	963	BDL	BDL
UA-11	Animas above Niagra Gulch	BDL	BDL	BDL	BDL	19	10	52	BDL	794	765	BDL	BDL
UA-12	Animas above Eureka Gulch	BDL	BDL	BDL	BDL	21	9	57	BDL	790	746	BDL	BDL
CG-2	California Gulch below Mtn. Queen	BDL	BDL	BDL	BDL	14	9	292	BDL	1590	1538	BDL	BDL
CG-3	Cal Gulch above DM-11-16	BDL	BDL	BDL	BDL	24	18	262	38	11120	11100	BDL	BDL
CG-4	Cal Gulch below DM-11-16	BDL	BDL	BDL	BDL	19	9	211	63	8182	8044	BDL	BDL
CG-5	Tributary below DM-17	BDL	BDL	BDL	BDL	244	228	184	163	1801	1760	BDL	BDL
CG-6	Cal Gulch below DM-17 tributary	BDL	BDL	BDL	BDL	16	9	296	58	8028	7982	BDL	BDL
CG-7	Cal Gulch above Placer Gulch	BDL	BDL	BDL	BDL	18	BDL	510	40	7355	7132	BDL	BDL
CG-8	Cal Gulch below Placer Gulch	BDL	BDL	BDL	BDL	24	11	471	73	4723	4451	BDL	BDL
CG-9	Cal Gulch below Bagley Mine Drainage	BDL	BDL	BDL	BDL	21	9	317	77	4337	4243	BDL	BDL
CG-10	Cal Gulch below Bagley Mill Tailings	BDL	BDL	BDL	BDL	21	9	294	79	4340	4326	BDL	BDL
CG-11	Cal Gulch above Columbus Mine	BDL	BDL	BDL	BDL	14	9	235	83	4306	4327	BDL	BDL
CG-12	Cal Gulch above Animas Confluence	BDL	BDL	BDL	BDL	25	14	229	81	4301	4303	BDL	BDL
BG-1	Burrows Creek above Trans-Basin Diversion	BDL	BDL	12	11	42	41	94	67	3047	2970	12	BDL
BG-2	Burrows Creek above London Mine	BDL	BDL	BDL	BDL	32	33	148	135	1969	2016	BDL	BDL
BG-3	Burrows Creek below London Mine	BDL	BDL	9	8	72	72	150	135	3283	3274	11	BDL
BG-4	Burrows Creek above Large Fault	BDL	BDL	BDL	10	63	65	119	106	2919	2919	BDL	BDL
BG-5	Burrows Creek above Animas	BDL	BDL	6	8	60	65	108	97	2821	2884	BDL	BDL
LJ-1	Animas below Lucky Jack Mine	BDL	BDL	BDL	BDL	BDL	BDL	127	25	165	170	BDL	BDL
HC-1	Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	15	6	1	1	BDL	BDL
PL-1	Placer Gulch	BDL	BDL	BDL	BDL	30	10	678	159	924	747	BDL	BDL
CN-1	Cinnamon Creek	BDL	BDL	BDL	BDL	BDL	BDL	15	6	2	BDL	BDL	BDL
GG-1	Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	17	BDL	2	BDL	BDL	BDL
PY-1	Picayune Gulch	BDL	BDL	BDL	BDL	BDL	BDL	63	BDL	22	14	BDL	BDL
BU-1	Burns Gulch	BDL	BDL	BDL	BDL	16	20	55	6	21	22	BDL	BDL
NG-1	Niagra Gulch	BDL	BDL	BDL	BDL	BDL	BDL	13	6	2	BDL	BDL	BDL

Upper Animas River Low-Flow
Raw Data

Site #	Description	Tot. Cr	Diss. Cr	Tot. Co	Diss. Co	Tot. Cu	Diss. Cu	Tot. Fe	Diss. Fe	Tot. Mn	Diss. Mn	Tot. Ni	Diss. Ni
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
DM-1	Unknown Prospect Above Denver Lake	BDL	5	7	12	58	66	1467	982	414	440	BDL	12
DM-2	Lucky Jack Mine Drainage	BDL	BDL	BDL	BDL	17	19	417	194	127	122	BDL	BDL
DM-3	Little Chief Mine Drainage	BDL	BDL	26	22	247	181	6017	4310	10330	7476	11	13
DM-4	Early Bird Mine Drainage	BDL	BDL	31	33	254	264	3157	2939	6618	6709	14	23
DM-5	Draining Mine near London Mine-West	BDL	BDL	BDL	BDL	BDL	4	9	8	1	1	BDL	BDL
DM-6	Draining Mine near London Mine-East	BDL	BDL	BDL	9	114	120	1907	1899	1188	1213	BDL	BDL
DM-7	London Mine Drainage	BDL	BDL	14	11	184	13	10060	737	1659	1722	BDL	BDL
DM-8	Prairie Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	113	6	82	87	BDL	BDL
DM-9	Riverside Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	55	41	117	112	BDL	BDL
DM-10	Mountain Queen Adit Drainage	BDL	BDL	BDL	9	2383	2262	9558	9082	3971	4091	15	BDL
DM-14	Little Idam Mine Drainage - Lower Adit	BDL	BDL	BDL	BDL	28	26	69	15	132	138	BDL	BDL
DM-15	Burrows Mine Drainage - West	BDL	BDL	BDL	BDL	64	67	6	7	826	859	BDL	BDL
DM-16	Burrows Mine Drainage - East	BDL	BDL	BDL	BDL	20	12	37	BDL	360	349	BDL	BDL
DM-17	Vermillion Mine Drainage	BDL	BDL	13	19	1362	1303	20750	20600	7256	7288	BDL	BDL
DM-18	Vermillion Tunnel Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	526	18	1165	1161	BDL	BDL
DM-19	Bagley Tunnel Drainage	BDL	18	6	BDL	BDL	BDL	1046	211	7342	7603	BDL	BDL
DM-20	Columbus Mine Drainage	BDL	BDL	224	230	7953	7707	74290	77410	13380	13610	70	75
DM-21	Silver Wing Mine Drainage	BDL	BDL	BDL	8	3257	1375	7125	1850	3369	3433	BDL	BDL
DM-22	Tom Moore Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	37	14	534	537	BDL	BDL
DM-24	Senator Mine Drainage	BDL	BDL	56	67	BDL	8	26300	26460	14880	15670	18	17
DM-25	Silver Queen Mine Drainage	BDL	BDL	29	27	2380	2319	15800	15430	68640	71600	18	21
DM-26	Sound Democrat Mine Drainage	BDL	BDL	13	14	281	285	269	258	42550	46370	13	17
DM-27	Golden Fleece Mine Drainage	BDL	BDL	6	9	35	41	1219	1279	6610	6952	BDL	BDL
DM-28	Indian Chief Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	72	12	640	603	BDL	BDL
DM-29	Toltec Mine Drainage	BDL	BDL	BDL	BDL	61	4	889	BDL	504	33	BDL	BDL
DM-30	Unknown Mine South of Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	103	7	182	175	BDL	BDL
DM-31	Unknown Prospect in Lower Burrows Creek	BDL	BDL	BDL	BDL	4	6	172	35	124	115	BDL	BDL

Upper Animas River Low-Flow
Raw Data

Site #	Description	Tot. Va	Diss. Va	Tot.Zn	Diss. Ca	Diss. Mg	Diss. K	Diss. Na	Diss. Zn	Hardness	Si	Cl	SO4
		ug/l	ug/l	ug/l	mg/l	mg/l	mg/l	mg/l	ug/l	mg/l CaCo3	mg/l	mg/l	mg/l
UA-1	Animas above Denver Lake	BDL	BDL	29	12.4	1.11	BDL	1.01	26	35.5	3.39	BDL	13.6
UA-2	Animas above Lucky Jack Mine	BDL	BDL	87	11.4	0.900	BDL	0.95	82	32.2	4.17	BDL	8.4
UA-3	Animas above Horseshoe Creek	BDL	BDL	81	11.7	1.16	BDL	0.44	84	34.00	1.29	BDL	18.3
UA-4	Animas below Burrows Creek	BDL	BDL	824	12.7	1.62	BDL	0.49	820	38.4	3.57	BDL	36.7
UA-5	Animas below mining complex	BDL	BDL	765	12.7	1.62	BDL	0.54	779	38.4	3.39	BDL	33.9
UA-6	Animas above California Gulch	BDL	BDL	714	13.1	1.58	BDL	0.500	715	39.2	3.37	BDL	32.6
UA-7	Animas below California Gulch	BDL	BDL	1198	25.8	2.76	BDL	0.94	1217	75.8	5.60	BDL	69.5
UA-8	Animas above Burns Gulch	BDL	BDL	553	30.3	2.55	BDL	0.84	534	86.2	3.92	BDL	56.2
UA-9	Animas below Burns Gulch	BDL	BDL	570	27.6	2.18	BDL	0.73	547	77.9	3.41	BDL	51.1
UA-10	Animas below Silver Wing Mine	4	BDL	589	28.3	2.27	BDL	0.79	566	80.00	3.43	BDL	51.5
UA-11	Animas above Niagra Gulch	BDL	BDL	528	29.8	2.26	BDL	0.86	514	83.7	3.92	BDL	53.2
UA-12	Animas above Eureka Gulch	BDL	BDL	536	29.1	2.20	BDL	0.81	514	81.7	3.88	BDL	52.6
CG-2	California Gulch below Mtn. Queen	BDL	BDL	232	52.00	5.24	BDL	0.96	252	151	4.85	BDL	123
CG-3	Cal Gulch above DM-11-16	BDL	BDL	1734	38.00	5.32	BDL	1.12	1776	117	8.93	BDL	133
CG-4	Cal Gulch below DM-11-16	BDL	BDL	1296	ND	ND	ND	ND	1316		7.48	BDL	103
CG-5	Tributary below DM-17	BDL	BDL	4809	8.13	0.93	BDL	0.26	4915	24.1	6.82	BDL	47.5
CG-6	Cal Gulch below DM-17 tributary	BDL	BDL	1279	30.3	4.10	BDL	1.00	1308	92.5	6.92	BDL	101
CG-7	Cal Gulch above Placer Gulch	BDL	BDL	1262	35.8	4.20	BDL	1.30	1232	107	6.94	BDL	107
CG-8	Cal Gulch below Placer Gulch	BDL	BDL	1116	27.5	3.10	BDL	1.02	1073	81.4	6.60	BDL	79.3
CG-9	Cal Gulch below Bagley Mine Drainage	BDL	BDL	1365	31.3	3.25	BDL	1.13	1289	91.5	6.45	BDL	87.9
CG-10	Cal Gulch below Bagley Mill Tailings	BDL	BDL	1225	31.3	3.27	BDL	1.16	1246	91.6	6.24	BDL	84.9
CG-11	Cal Gulch above Columbus Mine	BDL	BDL	1227	31.8	3.35	BDL	1.18	1255	93.2	6.35	BDL	84.1
CG-12	Cal Gulch above Animas Confluence	BDL	BDL	1440	ND	ND	ND	ND	1462	ND	6.15	BDL	85.0
BG-1	Burrows Creek above Trans-Basin Diversion	BDL	BDL	1969	9.36	1.30	BDL	0.20	2013	28.7	6.20	BDL	66.8
BG-2	Burrows Creek above London Mine	BDL	BDL	2265	9.94	1.18	BDL	0.35	2401	29.7	4.42	BDL	50.1
BG-3	Burrows Creek below London Mine	BDL	BDL	2510	14.2	2.38	BDL	0.81	2569	45.3	7.56	BDL	86.7
BG-4	Burrows Creek above Large Fault	BDL	BDL	2196	13.7	2.16	BDL	0.80	2284	43.1	6.86	BDL	76.0
BG-5	Burrows Creek above Animas	BDL	BDL	2148	14.2	2.19	BDL	0.80	2253	44.5	6.73	BDL	74.3
LJ-1	Animas below Lucky Jack Mine	BDL	BDL	999	ND	ND	ND	ND	1057	ND	5.32	BDL	32.0
HC-1	Horseshoe Creek	BDL	BDL	31	12.9	1.20	BDL	0.27	30	37.2	0.75	BDL	19.3
PL-1	Placer Gulch	BDL	BDL	893	17.0	1.63	BDL	0.62	898	49.2	4.94	BDL	41.8
CN-1	Cinnamon Creek	BDL	BDL	BDL	28.2	1.88	BDL	0.56	9	78.2	1.50	BDL	32.5
GG-1	Grouse Gulch	4	BDL	12	34.8	2.08	BDL	0.38	7	95.5	1.50	BDL	46.6
PY-1	Picayune Gulch	BDL	BDL	6	55.1	4.17	BDL	1.46	7	155	3.61	BDL	80.3
BU-1	Burns Gulch	BDL	BDL	544	21.9	1.22	BDL	0.57	579	ND	1.63	BDL	32.8
NG-1	Niagra Gulch	BDL	BDL	14	28.8	1.24	BDL	0.92	8	77.0	1.80	BDL	40.0

Upper Animas River Low-Flow
Raw Data

Site #	Description	Tot. Va	Diss. Va	Tot.Zn	Diss. Ca	Diss. Mg	Diss. K	Diss. Na	Diss. Zn	Hardness	Si	Cl	SO4
		ug/l	ug/l	ug/l	mg/l	mg/l	mg/l	mg/l	ug/l	mg/l CaCo3	mg/l	mg/l	mg/l
DM-1	Unknown Prospect Above Denver Lake	BDL	BDL	4459	24.7	3.91	BDL	0.58	4925	77.8	6.47	BDL	86.3
DM-2	Lucky Jack Mine Drainage	BDL	BDL	919	9.99	1.28	BDL	0.84	925	30.2	6.32	BDL	32.5
DM-3	Little Chief Mine Drainage	BDL	BDL	6259	19.5	2.70	BDL	0.30	4760	59.8	9.14	BDL	147
DM-4	Early Bird Mine Drainage	BDL	BDL	2184	32.7	6.84	2.28	0.32	2305	110	16.6	BDL	171
DM-5	Draining Mine near London Mine-West	BDL	BDL	22	13.1	0.64	BDL	0.69	26	35.3	2.76	BDL	12.0
DM-6	Draining Mine near London Mine-East	BDL	BDL	5681	17.7	1.29	BDL	1.22	6050	49.5	6.50	0.63	78.5
DM-7	London Mine Drainage	BDL	BDL	9713	63.3	4.26	BDL	5.57	9834	176	11.3	1.04	162
DM-8	Prairie Mine Drainage	BDL	BDL	861	43.1	2.97	BDL	2.80	947	120	8.59	0.56	57.4
DM-9	Riverside Mine Drainage	BDL	BDL	70	14.5	1.67	BDL	0.55	79	43.1	5.56	BDL	12.2
DM-10	Mountain Queen Adit Drainage	BDL	BDL	6209	14.6	1.70	BDL	0.46	6460	43.5	11.7	BDL	118
DM-14	Little Idam Mine Drainage - Lower Adit	BDL	BDL	688	17.1	1.02	BDL	0.78	775	46.9	5.52	BDL	27.2
DM-15	Burrows Mine Drainage - West	BDL	BDL	5243	13.4	1.27	BDL	0.48	5718	38.7	7.20	BDL	44.0
DM-16	Burrows Mine Drainage - East	BDL	BDL	6559	24.6	1.65	BDL	0.98	6938	68.2	6.75	BDL	57.3
DM-17	Vermillion Mine Drainage	BDL	BDL	49190	23.2	1.82	BDL	0.32	51660	65.4	12.5	BDL	251
DM-18	Vermillion Tunnel Mine Drainage	BDL	BDL	972	91.0	5.45	BDL	4.03	1010	250	10.2	BDL	165
DM-19	Bagley Tunnel Drainage	BDL	5	3375	118	7.61	2.10	4.77	3669	326	11.1	BDL	269
DM-20	Columbus Mine Drainage	BDL	BDL	237300	29.8	9.53	BDL	0.93	247800	114	32.6	0.51	1390
DM-21	Silver Wing Mine Drainage	BDL	BDL	3881	116	4.89	BDL	3.79	3855	310	14.1	BDL	267
DM-22	Tom Moore Mine Drainage	BDL	BDL	780	75.1	2.19	BDL	2.35	845	197	14.3	BDL	89.3
DM-24	Senator Mine Drainage	BDL	BDL	1687	233	24.6	3.14	6.62	1883	683	29.2	BDL	945
DM-25	Silver Queen Mine Drainage	BDL	BDL	7737	55.4	4.05	BDL	0.47	8414	155	10.2	BDL	540
DM-26	Sound Democrat Mine Drainage	BDL	BDL	8377	58.9	6.55	BDL	0.34	9427	174	11.8	BDL	261
DM-27	Golden Fleece Mine Drainage	BDL	BDL	1146	17.6	1.76	BDL	0.22	1257	51.2	7.77	BDL	84.3
DM-28	Indian Chief Mine Drainage	BDL	BDL	215	35.3	1.76	BDL	0.87	222	95.4	8.35	BDL	45.7
DM-29	Toltec Mine Drainage	4	BDL	145	60.7	8.69	BDL	5.14	27	187	8.23	BDL	83.8
DM-30	Unknown Mine South of Grouse Gulch	BDL	BDL	250	45.00	2.83	BDL	2.23	276	124	8.35	BDL	53.8
DM-31	Unknown Prospect in Lower Burrows Creek	BDL	BDL	422	16.00	1.200	BDL	0.55	419	44.9	5.11	BDL	22.8

Upper Animas River Low-Flow
Loading Data

Site #	Description	Tot. As g/day	Diss. As g/day	Tot. Cd g/day	Diss. Cd g/day	Tot. Pb g/day	Diss. Pb g/day	Tot. Se g/day	Diss. Se g/day	Tot. Ag g/day
UA-1	Animas above Denver Lake	0.66	BDL	BDL	BDL	0.20	BDL	BDL	BDL	BDL
UA-2	Animas above Lucky Jack Mine	0.13	BDL	0.06	0.06	0.08	BDL	BDL	BDL	BDL
UA-3	Animas above Horseshoe Creek	BDL	BDL	1.36	1.36	BDL	BDL	BDL	BDL	BDL
UA-4	Animas below Burrows Creek	BDL	BDL	35.20	40.23	10.69	9.43	BDL	BDL	BDL
UA-5	Animas below mining complex	BDL	BDL	23.95	28.26	46.94	36.88	BDL	BDL	BDL
UA-6	Animas above California Gulch	BDL	BDL	26.94	30.53	50.89	31.13	BDL	BDL	BDL
UA-7	Animas below California Gulch	BDL	BDL	64.76	74.20	175.38	41.82	BDL	BDL	BDL
UA-8	Animas above Burns Gulch	BDL	BDL	60.24	71.20	161.56	BDL	BDL	BDL	BDL
UA-9	Animas below Burns Gulch	BDL	BDL	77.47	105.64	207.76	31.69	BDL	BDL	BDL
UA-10	Animas below Silver Wing Mine	BDL	BDL	95.61	109.77	173.51	BDL	BDL	BDL	BDL
UA-11	Animas above Niagra Gulch	BDL	BDL	85.09	99.89	181.28	BDL	BDL	BDL	BDL
UA-12	Animas above Eureka Gulch	BDL	BDL	75.89	96.59	172.48	BDL	BDL	BDL	BDL
CG-2	California Gulch below Mtn. Queen	BDL	BDL	1.80	2.40	2.60	BDL	BDL	BDL	BDL
CG-3	Cal Gulch above DM-11-16	BDL	BDL	16.98	22.26	3.90	BDL	BDL	BDL	BDL
CG-4	Cal Gulch below DM-11-16	BDL	BDL	22.60	20.04	4.62	BDL	BDL	BDL	BDL
CG-5	Tributary below DM-17	BDL	BDL	1.63	1.62	22.91	20.94	BDL	BDL	BDL
CG-6	Cal Gulch below DM-17 tributary	BDL	BDL	30.22	37.77	6.92	BDL	BDL	BDL	BDL
CG-7	Cal Gulch above Placer Gulch	BDL	BDL	32.12	35.21	52.51	BDL	BDL	BDL	BDL
CG-8	Cal Gulch below Placer Gulch	BDL	BDL	40.32	46.52	551.05	45.49	BDL	BDL	2.07
CG-9	Cal Gulch below Bagley Mine Drainage	BDL	BDL	55.36	64.37	320.57	37.34	BDL	BDL	BDL
CG-10	Cal Gulch below Bagley Mill Tailings	BDL	BDL	54.15	64.22	251.86	32.74	BDL	BDL	BDL
CG-11	Cal Gulch above Columbus Mine	BDL	BDL	43.12	50.31	158.12	18.48	BDL	BDL	BDL
CG-12	Cal Gulch above Animas Confluence	BDL	BDL	47.42	39.18	163.92	27.83	BDL	BDL	BDL
BG-1	Burrows Creek above Trans-Basin Diversion	BDL	BDL	7.61	8.46	10.50	10.23	BDL	BDL	0.13
BG-2	Burrows Creek above London Mine	BDL	BDL	6.41	6.99	6.70	6.64	BDL	BDL	BDL
BG-3	Burrows Creek below London Mine	BDL	BDL	37.01	32.75	11.10	10.92	BDL	BDL	BDL
BG-4	Burrows Creek above Large Fault	BDL	BDL	27.97	29.32	10.03	10.22	BDL	BDL	BDL
BG-5	Burrows Creek above Animas	BDL	BDL	19.84	21.82	7.09	7.09	BDL	BDL	BDL
LJ-1	Animas below Lucky Jack Mine	BDL	BDL	0.40	0.37	BDL	BDL	BDL	BDL	BDL
HC-1	Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
PL-1	Placer Gulch	BDL	BDL	8.25	10.61	347.27	34.57	BDL	BDL	1.57
CN-1	Cinnamon Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GG-1	Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
PY-1	Picayune Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Upper Animas River Low-Flow
Loading Data

Site #	Description	Tot. As	Diss. As	Tot. Cd	Diss. Cd	Tot. Pb	Diss. Pb	Tot. Se	Diss. Se	Tot. Ag
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
BU-1	Burns Gulch	BDL	BDL	30.33	26.76	29.44	24.09	BDL	BDL	BDL
NG-1	Niagra Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-1	Unknown Prospect Above Denver Lake	BDL	BDL	0.02	0.03	0.24	0.28	BDL	BDL	0.00
DM-2	Lucky Jack Mine Drainage	0.47	BDL	0.82	0.94	66.99	56.86	BDL	BDL	BDL
DM-3	Little Chief Mine Drainage	BDL	BDL	0.44	0.31	0.09	0.06	BDL	BDL	0.00
DM-4	Early Bird Mine Drainage	BDL	BDL	0.01	0.01	0.06	0.06	BDL	BDL	0.00
DM-5	Draining Mine near London Mine-West	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00
DM-6	Draining Mine near London Mine-East	BDL	BDL	0.02	0.02	0.10	0.09	BDL	BDL	0.00
DM-7	London Mine Drainage	0.11	0.02	0.00	0.31	0.27	BDL	BDL	BDL	BDL
DM-8	Prairie Mine Drainage	BDL	BDL	0.01	0.01	0.00	BDL	BDL	BDL	BDL
DM-9	Riverside Mine Drainage	BDL	BDL	BDL	BDL	0.01	0.01	BDL	BDL	BDL
DM-10	Mountain Queen Adit Drainage	0.04	0.04	0.00	0.76	1.96	1.66	BDL	BDL	0.01
DM-14	Little Idam Mine Drainage - Lower Adit	BDL	BDL	0.03	0.04	0.41	0.35	BDL	BDL	BDL
DM-15	Burrows Mine Drainage - West	BDL	BDL	0.12	0.12	2.47	2.66	BDL	BDL	0.00
DM-16	Burrows Mine Drainage - East	BDL	BDL	0.14	0.15	0.03	BDL	BDL	BDL	BDL
DM-17	Vermillion Mine Drainage	0.63	0.78	BDL	8.26	BDL	63.09	BDL	BDL	0.05
DM-18	Vermillion Tunnel Mine Drainage	0.94	0.70	1.64	1.94	1.82	0.65	BDL	BDL	BDL
DM-19	Bagley Tunnel Drainage	0.62	BDL	3.97	4.11	0.40	BDL	BDL	BDL	BDL
DM-20	Columbus Mine Drainage	0.18	0.21	BDL	7.61	BDL	2.59	BDL	BDL	0.00
DM-21	Silver Wing Mine Drainage	1.37	0.35	1.25	1.32	0.70	BDL	BDL	BDL	BDL
DM-22	Tom Moore Mine Drainage	BDL	BDL	0.42	0.35	0.19	BDL	BDL	BDL	BDL
DM-24	Senator Mine Drainage	0.84	0.56	1.60	1.56	9.73	2.71	BDL	BDL	BDL
DM-25	Silver Queen Mine Drainage	0.00	0.00	0.05	0.05	0.57	0.61	BDL	BDL	0.00
DM-26	Sound Democrat Mine Drainage	BDL	BDL	0.49	0.44	3.29	2.94	BDL	BDL	0.00
DM-27	Golden Fleece Mine Drainage	BDL	BDL	0.16	0.15	1.45	1.34	BDL	BDL	0.01
DM-28	Indian Chief Mine Drainage	0.07	0.06	0.01	0.01	0.38	0.22	BDL	BDL	BDL
DM-29	Toltec Mine Drainage	0.03	0.01	0.00	BDL	0.08	BDL	BDL	BDL	BDL
DM-30	Unknown Mine South of Grouse Gulch	BDL	BDL	BDL	BDL	0.01	BDL	BDL	BDL	BDL
DM-31	Unknown Prospect in Lower Burrows Creek	BDL	BDL	0.01	0.01	0.06	0.02	BDL	BDL	BDL

Upper Animas River Low-Flow
Loading Data

Site #	Description	Diss. Ag	Tot. Th	Diss. Th	Tot. Al	Diss. Al	Tot. Sb	Diss. Sb	Tot. Ba	Diss. Ba	Tot. Be
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
UA-1	Animas above Denver Lake	BDL	BDL	BDL	39.19	BDL	BDL	BDL	2.13	1.80	BDL
UA-2	Animas above Lucky Jack Mine	BDL	BDL	BDL	3.27	BDL	BDL	BDL	0.57	0.50	BDL
UA-3	Animas above Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	18.13	15.87	BDL
UA-4	Animas below Burrows Creek	BDL	BDL	BDL	11936.01	2973.00	BDL	BDL	81.71	81.71	6.29
UA-5	Animas below mining complex	BDL	BDL	BDL	6337.09	493.36	BDL	BDL	67.06	62.27	4.79
UA-6	Animas above California Gulch	BDL	BDL	BDL	5968.85	BDL	BDL	BDL	83.82	77.83	5.99
UA-7	Animas below California Gulch	BDL	BDL	BDL	19089.94	1443.55	BDL	BDL	202.37	202.37	26.98
UA-8	Animas above Burns Gulch	BDL	BDL	BDL	13609.68	1095.35	BDL	BDL	383.37	410.75	27.38
UA-9	Animas below Burns Gulch	BDL	BDL	BDL	14578.39	1443.75	BDL	BDL	457.78	422.56	35.21
UA-10	Animas below Silver Wing Mine	BDL	BDL	BDL	14624.05	BDL	BDL	BDL	460.32	460.32	35.41
UA-11	Animas above Niagra Gulch	BDL	BDL	BDL	10913.63	1553.80	BDL	BDL	443.94	443.94	BDL
UA-12	Animas above Eureka Gulch	BDL	BDL	BDL	11004.34	BDL	BDL	BDL	413.96	413.96	34.50
CG-2	California Gulch below Mtn. Queen	BDL	BDL	BDL	2502.66	630.67	BDL	BDL	52.06	52.06	6.01
CG-3	Cal Gulch above DM-11-16	BDL	BDL	BDL	14067.62	9965.61	BDL	BDL	58.44	52.88	25.05
CG-4	Cal Gulch below DM-11-16	BDL	BDL	BDL	21038.04	12263.20	BDL	BDL	82.20	82.20	35.96
CG-5	Tributary below DM-17	BDL	BDL	BDL	208.13	205.02	BDL	BDL	1.44	1.37	0.08
CG-6	Cal Gulch below DM-17 tributary	BDL	BDL	BDL	26760.92	13182.16	BDL	BDL	100.72	94.43	44.07
CG-7	Cal Gulch above Placer Gulch	BDL	BDL	BDL	28880.85	4497.38	BDL	BDL	105.02	92.67	43.24
CG-8	Cal Gulch below Placer Gulch	BDL	BDL	BDL	27738.54	4559.34	BDL	BDL	186.10	165.42	41.35
CG-9	Cal Gulch below Bagley Mine Drainage	BDL	BDL	BDL	24100.75	3694.93	BDL	BDL	205.99	193.12	38.62
CG-10	Cal Gulch below Bagley Mill Tailings	BDL	BDL	BDL	23082.71	3526.00	BDL	BDL	214.08	201.49	37.78
CG-11	Cal Gulch above Columbus Mine	BDL	BDL	BDL	16633.59	2104.87	BDL	BDL	164.28	164.28	30.80
CG-12	Cal Gulch above Animas Confluence	BDL	BDL	BDL	16876.25	2268.04	BDL	BDL	164.95	164.95	30.93
BG-1	Burrows Creek above Trans-Basin Diversion	BDL	BDL	BDL	4594.96	4486.73	BDL	BDL	11.81	11.15	0.66
BG-2	Burrows Creek above London Mine	BDL	BDL	BDL	1934.70	1989.69	BDL	BDL	18.33	18.33	0.57
BG-3	Burrows Creek below London Mine	BDL	BDL	BDL	12044.12	12305.02	BDL	BDL	44.41	44.41	5.55
BG-4	Burrows Creek above Large Fault	BDL	BDL	BDL	10899.10	10983.96	BDL	BDL	42.43	40.50	3.86
BG-5	Burrows Creek above Animas	BDL	BDL	BDL	7595.95	7818.45	BDL	BDL	29.76	29.76	2.83
LJ-1	Animas below Lucky Jack Mine	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.32	1.32	BDL
HC-1	Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	14.01	16.35	BDL
PL-1	Placer Gulch	BDL	BDL	BDL	4490.14	BDL	BDL	BDL	78.57	66.78	3.93
CN-1	Cinnamon Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	35.87	35.87	BDL
GG-1	Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	32.04	38.45	BDL
PY-1	Picayune Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	182.22	182.22	BDL

Upper Animas River Low-Flow
Loading Data

Site #	Description	Diss. Ag	Tot. Th	Diss. Th	Tot. Al	Diss. Al	Tot. Sb	Diss. Sb	Tot. Ba	Diss. Ba	Tot. Be
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
BU-1	Burns Gulch	BDL	BDL	BDL	BDL	419.31	BDL	BDL	71.37	71.37	BDL
NG-1	Niagra Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	16.58	20.72	BDL
DM-1	Unknown Prospect Above Denver Lake	BDL	BDL	BDL	0.48	0.54	BDL	BDL	0.01	0.01	0.00
DM-2	Lucky Jack Mine Drainage	BDL	BDL	BDL	75.89	64.52	BDL	BDL	5.44	4.94	BDL
DM-3	Little Chief Mine Drainage	0.00	BDL	BDL	128.74	94.70	BDL	BDL	0.09	0.06	0.02
DM-4	Early Bird Mine Drainage	0.00	BDL	BDL	4.40	4.49	BDL	BDL	0.01	0.01	0.00
DM-5	Draining Mine near London Mine-West	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	0.01	BDL
DM-6	Draining Mine near London Mine-East	0.00	BDL	BDL	0.31	0.32	BDL	BDL	0.01	0.01	0.00
DM-7	London Mine Drainage	BDL	BDL	BDL	4.52	BDL	BDL	BDL	0.04	0.04	0.00
DM-8	Prairie Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.03	0.03	BDL
DM-9	Riverside Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	0.01	BDL
DM-10	Mountain Queen Adit Drainage	0.01	BDL	BDL	47.61	49.29	BDL	BDL	0.21	0.23	0.02
DM-14	Little Idam Mine Drainage - Lower Adit	BDL	BDL	BDL	1.91	0.95	BDL	BDL	0.02	0.02	BDL
DM-15	Burrows Mine Drainage - West	BDL	BDL	BDL	2.77	2.46	BDL	BDL	0.15	0.15	0.00
DM-16	Burrows Mine Drainage - East	BDL	BDL	BDL	3.41	0.29	BDL	BDL	0.07	0.06	0.01
DM-17	Vermillion Mine Drainage	0.04	BDL	BDL	121.05	120.58	BDL	BDL	0.23	0.16	0.08
DM-18	Vermillion Tunnel Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11.16	10.57	BDL
DM-19	Bagley Tunnel Drainage	BDL	BDL	BDL	29.37	49.56	BDL	BDL	4.41	4.04	0.37
DM-20	Columbus Mine Drainage	BDL	BDL	BDL	136.94	138.56	BDL	BDL	0.04	0.04	0.04
DM-21	Silver Wing Mine Drainage	BDL	BDL	BDL	78.97	36.95	BDL	BDL	1.99	1.90	0.18
DM-22	Tom Moore Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.06	1.06	BDL
DM-24	Senator Mine Drainage	BDL	BDL	BDL	694.59	668.25	BDL	BDL	4.39	4.79	2.39
DM-25	Silver Queen Mine Drainage	0.00	BDL	BDL	2.41	2.34	BDL	BDL	0.02	0.02	0.01
DM-26	Sound Democrat Mine Drainage	0.00	BDL	BDL	28.51	29.84	BDL	BDL	0.12	0.14	0.04
DM-27	Golden Fleece Mine Drainage	0.01	BDL	BDL	33.62	34.95	BDL	BDL	0.23	0.23	0.02
DM-28	Indian Chief Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.12	0.12	BDL
DM-29	Toltec Mine Drainage	BDL	BDL	BDL	0.77	BDL	BDL	BDL	0.09	0.05	BDL
DM-30	Unknown Mine South of Grouse Gulch	BDL	BDL	BDL	0.34	BDL	BDL	BDL	0.04	0.03	BDL
DM-31	Unknown Prospect in Lower Burrows Creek	BDL	BDL	BDL	0.36	BDL	BDL	BDL	0.07	0.06	BDL

Upper Animas River Low-Flow
Loading Data

Site #	Description	Diss. Be	Tot. Cr	Diss. Cr	Tot. Co	Diss. Co	Tot. Cu	Diss. Cu	Tot. Fe	Diss. Fe
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
UA-1	Animas above Denver Lake	BDL	BDL	BDL	BDL	BDL	BDL	0.66	102.98	28.53
UA-2	Animas above Lucky Jack Mine	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.55	BDL
UA-3	Animas above Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	43.06	13.60
UA-4	Animas below Burrows Creek	6.29	BDL	BDL	BDL	BDL	150.85	125.71	276.56	144.56
UA-5	Animas below mining complex	4.79	BDL	BDL	BDL	BDL	95.80	76.64	196.39	86.22
UA-6	Animas above California Gulch	BDL	BDL	BDL	BDL	BDL	95.79	59.87	191.58	35.92
UA-7	Animas below California Gulch	13.49	BDL	BDL	BDL	BDL	296.80	134.91	2131.60	755.50
UA-8	Animas above Burns Gulch	BDL	BDL	BDL	BDL	BDL	164.30	BDL	1779.94	BDL
UA-9	Animas below Burns Gulch	BDL	BDL	BDL	BDL	BDL	387.35	140.85	2042.38	BDL
UA-10	Animas below Silver Wing Mine	BDL	BDL	BDL	BDL	BDL	956.05	424.91	2514.06	BDL
UA-11	Animas above Niagra Gulch	BDL	BDL	BDL	BDL	BDL	702.91	369.95	1923.76	BDL
UA-12	Animas above Eureka Gulch	BDL	BDL	BDL	BDL	BDL	724.42	310.47	1966.29	BDL
CG-2	California Gulch below Mtn. Queen	6.01	BDL	BDL	BDL	BDL	28.03	18.02	584.62	BDL
CG-3	Cal Gulch above DM-11-16	19.48	BDL	BDL	BDL	BDL	66.79	50.09	729.12	105.75
CG-4	Cal Gulch below DM-11-16	25.69	BDL	BDL	BDL	BDL	97.61	46.24	1084.01	323.66
CG-5	Tributary below DM-17	0.08	BDL	BDL	BDL	BDL	18.51	17.30	13.96	12.37
CG-6	Cal Gulch below DM-17 tributary	31.48	BDL	BDL	BDL	BDL	100.72	56.66	1863.38	365.12
CG-7	Cal Gulch above Placer Gulch	24.71	BDL	BDL	BDL	BDL	111.20	BDL	3150.64	247.11
CG-8	Cal Gulch below Placer Gulch	20.68	BDL	BDL	BDL	BDL	248.13	113.72	4869.49	754.72
CG-9	Cal Gulch below Bagley Mine Drainage	25.75	BDL	BDL	BDL	BDL	270.36	115.87	4081.16	991.32
CG-10	Cal Gulch below Bagley Mill Tailings	25.19	BDL	BDL	BDL	BDL	264.45	113.34	3702.30	994.84
CG-11	Cal Gulch above Columbus Mine	20.54	BDL	BDL	BDL	BDL	143.75	92.41	2412.90	852.21
CG-12	Cal Gulch above Animas Confluence	20.62	BDL	BDL	BDL	BDL	257.73	144.33	2360.82	835.05
BG-1	Burrows Creek above Trans-Basin Diversion	0.66	BDL	BDL	7.87	7.22	27.55	26.89	61.66	43.95
BG-2	Burrows Creek above London Mine	0.57	BDL	BDL	BDL	BDL	18.33	18.90	84.77	77.32
BG-3	Burrows Creek below London Mine	5.55	BDL	BDL	16.65	14.80	133.23	133.23	277.56	249.80
BG-4	Burrows Creek above Large Fault	5.79	BDL	BDL	BDL	19.29	121.51	125.37	229.52	204.44
BG-5	Burrows Creek above Animas	4.25	BDL	BDL	8.50	11.34	85.03	92.12	153.05	137.46
LJ-1	Animas below Lucky Jack Mine	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9.33	1.84
HC-1	Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	35.03	14.01
PL-1	Placer Gulch	3.93	BDL	BDL	BDL	BDL	117.85	39.28	2663.45	624.61
CN-1	Cinnamon Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	67.26	26.90
GG-1	Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	54.47	BDL
PY-1	Picayune Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	347.87	BDL

Upper Animas River Low-Flow
Loading Data

Site #	Description	Diss. Be	Tot. Cr	Diss. Cr	Tot. Co	Diss. Co	Tot. Cu	Diss. Cu	Tot. Fe	Diss. Fe
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
BU-1	Burns Gulch	BDL	BDL	BDL	BDL	BDL	142.74	178.43	490.68	53.53
NG-1	Niagra Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	53.87	24.86
DM-1	Unknown Prospect Above Denver Lake	0.00	BDL	0.00	0.01	0.01	0.04	0.05	1.08	0.72
DM-2	Lucky Jack Mine Drainage	BDL	BDL	BDL	BDL	BDL	4.20	4.70	103.09	47.96
DM-3	Little Chief Mine Drainage	0.02	BDL	BDL	0.32	0.27	3.02	2.22	73.64	52.75
DM-4	Early Bird Mine Drainage	0.00	BDL	BDL	0.02	0.02	0.19	0.19	2.32	2.16
DM-5	Draining Mine near London Mine-West	BDL	BDL	BDL	BDL	BDL	BDL	0.00	0.01	0.01
DM-6	Draining Mine near London Mine-East	0.00	BDL	BDL	BDL	0.01	0.08	0.09	1.40	1.39
DM-7	London Mine Drainage	0.00	BDL	BDL	0.07	0.05	0.90	0.06	49.25	3.61
DM-8	Prairie Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.28	0.01
DM-9	Riverside Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.04	0.03
DM-10	Mountain Queen Adit Drainage	0.02	BDL	BDL	BDL	0.11	29.16	27.68	116.97	111.15
DM-14	Little Idam Mine Drainage - Lower Adit	BDL	BDL	BDL	BDL	BDL	0.27	0.25	0.68	0.15
DM-15	Burrows Mine Drainage - West	0.00	BDL	BDL	BDL	BDL	0.31	0.33	0.03	0.03
DM-16	Burrows Mine Drainage - East	0.01	BDL	BDL	BDL	BDL	0.15	0.09	0.27	BDL
DM-17	Vermillion Mine Drainage	0.08	BDL	BDL	0.51	0.74	53.34	51.03	812.60	806.73
DM-18	Vermillion Tunnel Mine Drainage	0.59	BDL	BDL	BDL	BDL	BDL	BDL	308.98	10.57
DM-19	Bagley Tunnel Drainage	0.37	BDL	6.61	2.20	BDL	BDL	BDL	384.03	77.47
DM-20	Columbus Mine Drainage	0.04	BDL	BDL	1.64	1.69	58.40	56.59	545.49	568.40
DM-21	Silver Wing Mine Drainage	0.18	BDL	BDL	BDL	0.72	294.96	124.52	645.25	167.54
DM-22	Tom Moore Mine Drainage	0.18	BDL	BDL	BDL	BDL	BDL	BDL	6.52	2.47
DM-24	Senator Mine Drainage	2.39	BDL	BDL	22.34	26.73	BDL	3.19	10492.58	10556.42
DM-25	Silver Queen Mine Drainage	0.01	BDL	BDL	0.05	0.05	4.08	3.97	27.07	26.44
DM-26	Sound Democrat Mine Drainage	0.06	BDL	BDL	0.25	0.27	5.50	5.58	5.27	5.05
DM-27	Golden Fleece Mine Drainage	0.04	BDL	BDL	0.12	0.18	0.69	0.80	23.87	25.04
DM-28	Indian Chief Mine Drainage	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.70	0.12
DM-29	Toltec Mine Drainage	BDL	BDL	BDL	BDL	BDL	0.22	0.01	3.26	BDL
DM-30	Unknown Mine South of Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.33	0.02
DM-31	Unknown Prospect in Lower Burrows Creek	BDL	BDL	BDL	BDL	BDL	0.02	0.03	0.93	0.19

Upper Animas River Low-Flow
Loading Data

Site #	Description	Tot. Mn	Diss. Mn	Tot. Ni	Diss. Ni	Tot. Va	Diss. Va	Tot.Zn	Diss. Zn
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
UA-1	Animas above Denver Lake	13.12	9.84	BDL	BDL	BDL	BDL	4.76	4.26
UA-2	Animas above Lucky Jack Mine	0.14	0.07	BDL	BDL	BDL	BDL	6.18	5.82
UA-3	Animas above Horseshoe Creek	18.13	18.13	BDL	BDL	BDL	BDL	183.58	190.38
UA-4	Animas below Burrows Creek	6279.13	6008.86	BDL	BDL	BDL	BDL	5179.18	5154.04
UA-5	Animas below mining complex	3573.29	3458.33	BDL	BDL	BDL	BDL	3664.30	3731.36
UA-6	Animas above California Gulch	3675.90	3532.22	BDL	BDL	BDL	BDL	4274.58	4280.57
UA-7	Animas below California Gulch	41174.92	40432.91	BDL	BDL	BDL	BDL	16162.37	16418.70
UA-8	Animas above Burns Gulch	34558.18	34256.96	BDL	BDL	BDL	BDL	15143.16	14622.87
UA-9	Animas below Burns Gulch	34720.52	33347.19	BDL	BDL	BDL	BDL	20071.70	19261.79
UA-10	Animas below Silver Wing Mine	35232.27	34099.17	BDL	BDL	141.64	BDL	20856.09	20041.67
UA-11	Animas above Niagra Gulch	29374.31	28301.45	BDL	BDL	BDL	BDL	19533.55	19015.61
UA-12	Animas above Eureka Gulch	27252.13	25734.29	BDL	BDL	BDL	BDL	18490.05	17731.13
CG-2	California Gulch below Mtn. Queen	3183.39	3079.28	BDL	BDL	BDL	BDL	464.49	504.54
CG-3	Cal Gulch above DM-11-16	30945.98	30890.32	BDL	BDL	BDL	BDL	4825.57	4942.45
CG-4	Cal Gulch below DM-11-16	42034.99	41326.01	BDL	BDL	BDL	BDL	6658.19	6760.94
CG-5	Tributary below DM-17	136.65	133.54	BDL	BDL	BDL	BDL	364.88	372.93
CG-6	Cal Gulch below DM-17 tributary	50537.92	50248.34	BDL	BDL	BDL	BDL	8051.57	8234.13
CG-7	Cal Gulch above Placer Gulch	45437.15	44059.51	BDL	BDL	BDL	BDL	7796.29	7610.95
CG-8	Cal Gulch below Placer Gulch	48829.34	46017.24	BDL	BDL	BDL	BDL	11537.91	11093.35
CG-9	Cal Gulch below Bagley Mine Drainage	55835.99	54625.80	BDL	BDL	BDL	BDL	17573.47	16595.02
CG-10	Cal Gulch below Bagley Mill Tailings	54653.02	54476.72	BDL	BDL	BDL	BDL	15426.25	15690.70
CG-11	Cal Gulch above Columbus Mine	44212.49	44428.11	BDL	BDL	BDL	BDL	12598.40	12885.90
CG-12	Cal Gulch above Animas Confluence	44340.12	44360.74	BDL	BDL	BDL	BDL	14845.33	15072.13
BG-1	Burrows Creek above Trans-Basin Diversion	1998.69	1948.19	7.87	BDL	BDL	BDL	1291.57	1320.44
BG-2	Burrows Creek above London Mine	1127.72	1154.64	BDL	BDL	BDL	BDL	1297.25	1375.14
BG-3	Burrows Creek below London Mine	6074.80	6058.14	20.35	BDL	BDL	BDL	4644.45	4753.63
BG-4	Burrows Creek above Large Fault	5629.88	5629.88	BDL	BDL	BDL	BDL	4235.43	4405.16
BG-5	Burrows Creek above Animas	3997.80	4087.08	BDL	BDL	BDL	BDL	3044.05	3192.85
LJ-1	Animas below Lucky Jack Mine	12.12	12.48	BDL	BDL	BDL	BDL	73.35	77.61
HC-1	Horseshoe Creek	2.34	2.34	BDL	BDL	BDL	BDL	72.39	70.05
PL-1	Placer Gulch	3629.83	2934.50	BDL	BDL	BDL	BDL	3508.05	3527.69
CN-1	Cinnamon Creek	8.97	BDL	BDL	BDL	BDL	BDL	BDL	40.36
GG-1	Grouse Gulch	6.41	BDL	BDL	BDL	12.82	BDL	38.45	22.43
PY-1	Picayune Gulch	121.48	77.30	BDL	BDL	BDL	BDL	33.13	38.65

Upper Animas River Low-Flow
Loading Data

Site #	Description	Tot. Mn	Diss. Mn	Tot. Ni	Diss. Ni	Tot. Va	Diss. Va	Tot.Zn	Diss. Zn
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
BU-1	Burns Gulch	187.35	196.27	BDL	BDL	BDL	BDL	4853.28	5165.53
NG-1	Niagra Gulch	8.29	BDL	BDL	BDL	BDL	BDL	58.01	33.15
DM-1	Unknown Prospect Above Denver Lake	0.30	0.32	BDL	0.01	BDL	BDL	3.27	3.62
DM-2	Lucky Jack Mine Drainage	31.40	30.16	BDL	BDL	BDL	BDL	227.18	228.67
DM-3	Little Chief Mine Drainage	126.42	91.49	0.13	0.16	BDL	BDL	76.60	58.25
DM-4	Early Bird Mine Drainage	4.86	4.93	0.01	0.02	BDL	BDL	1.60	1.69
DM-5	Draining Mine near London Mine-West	0.00	0.00	BDL	BDL	BDL	BDL	0.02	0.02
DM-6	Draining Mine near London Mine-East	0.87	0.89	BDL	BDL	BDL	BDL	4.17	4.44
DM-7	London Mine Drainage	8.12	8.43	BDL	BDL	BDL	BDL	47.55	48.14
DM-8	Prairie Mine Drainage	0.20	0.21	BDL	BDL	BDL	BDL	2.11	2.32
DM-9	Riverside Mine Drainage	0.09	0.08	BDL	BDL	BDL	BDL	0.05	0.06
DM-10	Mountain Queen Adit Drainage	48.60	50.07	0.18	BDL	BDL	BDL	75.99	79.06
DM-14	Little Idam Mine Drainage - Lower Adit	1.29	1.35	BDL	BDL	BDL	BDL	6.74	7.59
DM-15	Burrows Mine Drainage - West	4.04	4.20	BDL	BDL	BDL	BDL	25.67	27.99
DM-16	Burrows Mine Drainage - East	2.64	2.56	BDL	BDL	BDL	BDL	48.16	50.94
DM-17	Vermillion Mine Drainage	284.16	285.41	BDL	BDL	BDL	BDL	1926.35	2023.08
DM-18	Vermillion Tunnel Mine Drainage	684.35	682.00	BDL	BDL	BDL	BDL	570.97	593.30
DM-19	Bagley Tunnel Drainage	2695.53	2791.36	BDL	BDL	BDL	1.84	1239.09	1347.03
DM-20	Columbus Mine Drainage	98.25	99.94	0.51	0.55	BDL	BDL	1742.44	1819.54
DM-21	Silver Wing Mine Drainage	305.10	310.90	BDL	BDL	BDL	BDL	351.47	349.11
DM-22	Tom Moore Mine Drainage	94.11	94.63	BDL	BDL	BDL	BDL	137.46	148.91
DM-24	Senator Mine Drainage	5936.49	6251.66	7.18	6.78	BDL	BDL	673.04	751.24
DM-25	Silver Queen Mine Drainage	117.60	122.67	0.03	0.04	#VALUE!	BDL	13.26	14.42
DM-26	Sound Democrat Mine Drainage	833.16	907.96	0.25	0.33	#VALUE!	BDL	164.03	184.59
DM-27	Golden Fleece Mine Drainage	129.43	136.13	BDL	BDL	#VALUE!	BDL	22.44	24.61
DM-28	Indian Chief Mine Drainage	6.27	5.90	BDL	BDL	#VALUE!	BDL	2.10	2.17
DM-29	Toltec Mine Drainage	1.85	0.12	BDL	BDL	0.01	BDL	0.53	0.10
DM-30	Unknown Mine South of Grouse Gulch	0.58	0.56	BDL	BDL	BDL	BDL	0.80	0.88
DM-31	Unknown Prospect in Lower Burrows Creek	0.67	0.62	BDL	BDL	BDL	BDL	2.27	2.26

APPENDIX 2

Upper Animas River High-Flow
Raw Data

Site #	Description	Sample Time	Flow Time	Adjusted Flow cfs	pH s.u.	Cond. umhos/cm	Temp. Deg C	Tot. Al ug/l	Tot. Ba ug/l	Tot. Be ug/l	Tot. Co ug/l	Tot. Cr ug/l	Tot. Cu ug/l	Tot. Fe ug/l	Tot. Mn ug/l	Tot. Ni ug/l	Tot. Sb ug/l
UA-1	Animas above Denver Lake	1445	1500	0.676	7.01	118	18	BDL	BDL	BDL	BDL	BDL	7.68	347	35.8	BDL	BDL
UA-2	Animas above Lucky Jack Mine	1517	1520	0.479	7.43	41	11	BDL	BDL	BDL	BDL	10.8	BDL	36	BDL	BDL	BDL
UA-3	Animas above Horseshoe Creek	1520	1205	2.015	6.62	49	13	93	BDL	BDL	BDL	BDL	BDL	210	24.2	BDL	BDL
UA-4	Animas below Burrows Creek	1600	1145	14.900	6.53	56	8	827	BDL	BDL	BDL	BDL	9.79	103	545	BDL	BDL
UA-5	Animas below mining complex	1550	1245	17.700	6.75	54	9	685	BDL	BDL	BDL	BDL	11.5	95	452	BDL	BDL
UA-6a	Animas above Cal Gulch	1050	1050	20.032	7.01	68		572	BDL	BDL	BDL	BDL	6.84	71.1	414	BDL	BDL
UA-6b	Animas above Cal Gulch	1200	1200	16.673	7.43	69		518	BDL	BDL	BDL	BDL	8.55	83.7	377	BDL	BDL
UA-6c	Animas above Cal Gulch	1320	1320	17.096	7.2	61		526	BDL	BDL	BDL	BDL	8.3	93	386	BDL	BDL
UA-6d	Animas above Cal Gulch	1500	1500	19.73	7.44	57		544	BDL	BDL	BDL	BDL	5.81	80.9	384	BDL	BDL
UA-6e	Animas above Cal Gulch	1540	1540	19.08	7.32	59		583	BDL	BDL	BDL	BDL	7.79	104	397	BDL	BDL
UA-6f	Animas above Cal Gulch	1845	1845	20.006	7.5	19		572	BDL	BDL	BDL	BDL	6.84	71.1	414	BDL	BDL
UA-7	Animas below California Gulch	1500	1345	66.019	6.61	96	9	1150	BDL	BDL	BDL	BDL	18.1	358	1880	BDL	BDL
UA-11	Animas above Niagra Gulch	1525	1145	106.455	6.95	65	10	408	BDL	BDL	BDL	BDL	10.2	98.5	895	BDL	BDL
UA-12a	Animas above Eureka Gulch 1020	1000	1025	111.69	7.5	96	6	314	BDL	BDL	BDL	BDL	9.11	66.1	824	BDL	BDL
UA-12b	Animas above Eureka Gulch	1100	1120	107.9	7.4	96	8	316	BDL	BDL	BDL	BDL	9.81	68.7	837	BDL	BDL
UA-12c	Animas above Eureka Gulch	1200	1220	110.5	7.55	98	10	329	BDL	BDL	BDL	BDL	10.6	88.7	822	BDL	BDL
UA-12d	Animas above Eureka Gulch	1300	1320	112.7	7.6	98	10	336	BDL	BDL	BDL	BDL	11.4	77.8	869	BDL	BDL
UA-12e	Animas above Eureka Gulch	1400	1420	116.88	7.6	98	10	429	BDL	BDL	BDL	BDL	10.3	166	861	BDL	BDL
UA-12f	Animas above Eureka Gulch	1500	1520	121.19	7.3	98	10	423	BDL	BDL	BDL	BDL	12	92.4	904	BDL	BDL
CG-1	California Gulch Above Mtn. Queen	1620	1625	0.146	6.74	54	6	187	BDL	BDL	BDL	BDL	9.71	153	157	BDL	BDL
CG-2	California Gulch below Mtn. Queen	1547	1125	7.469	ND	ND	ND	2090	BDL	BDL	BDL	BDL	45.8	2820	390	BDL	BDL
CG-3	Cal Gulch above DM-11-16	1555	1215	16.623	5.66	121	9	3580	BDL	BDL	BDL	BDL	31.2	2160	4990	BDL	BDL
CG-4	Cal Gulch below DM-11-16	1510	1250	22.176	5.8	120	12	3360	BDL	BDL	BDL	BDL	28.1	2220	4180	BDL	BDL
CG-5	Tributary below DM-17	1540	1310	0.816	4.36	60	11	503	BDL	BDL	BDL	BDL	67.1	170	481	BDL	BDL
CG-6	Cal Gulch below DM-17 tributary	1650	1135	24.454	5.91	69	7	2490	BDL	BDL	BDL	BDL	27.6	1180	4040	BDL	BDL
CG-7	Cal Gulch above Placer Gulch	1445	1545	25.560	5.91	70	6	3060	BDL	BDL	BDL	BDL	24	1830	3750	BDL	BDL
CG-8	Cal Gulch below Placer Gulch	1510	1200	38.504	6.2	77	9	2220	BDL	BDL	BDL	BDL	28.3	1600	2720	BDL	BDL
CG-9	Cal Gulch below Bagley Mine Drainage	1547	1300	45.671	6.27	74	8	1540	BDL	BDL	BDL	BDL	24.5	802	2580	BDL	BDL
CG-10	Cal Gulch below Bagley Mill Tailings	1620	1345	43.569	6.36	72	7	1170	BDL	BDL	BDL	BDL	22.9	441	2390	BDL	BDL
CG-11	Cal Gulch above Columbus Mine	1650	1535	52.401	6.38	86	7	1210	BDL	BDL	BDL	BDL	23	492	2390	BDL	BDL
CG-12a	Cal Gulch at Mouth	1045	1020	35.035	6.5	126		963	BDL	BDL	BDL	BDL	17.8	121	2620	BDL	BDL
CG-12b	Cal Gulch at Mouth	1145	1145	38.098	6.73	128		965	BDL	BDL	BDL	BDL	18.7	162	2500	BDL	BDL
CG-12c	Cal Gulch at Mouth	1237	1230	36.62	6.89	127		975	BDL	BDL	BDL	BDL	19.1	140	2670	BDL	BDL
CG-12d	Cal Gulch at Mouth	1330	1345	40.986	6.99	114		1030	BDL	BDL	BDL	BDL	20.9	173	2550	BDL	BDL
CG-12e	Cal Gulch at Mouth	1445	1435	42.687	6.94	117		1250	BDL	BDL	BDL	BDL	21.8	410	2460	BDL	BDL
CG-12f	Cal Gulch at Mouth	1620	1620	50.185	7.15	99		1810	BDL	BDL	BDL	BDL	26.9	1130	2260	BDL	BDL
CG-13	Duplicate of CG-4 metals & CG-3 Anions	1510						BDL	BDL	BDL	BDL	BDL	BDL	23.4	82.9	BDL	BDL
BG-2	Burrows Creek above London Mine	1430	1010	0.942	4.08	176	14	4740	BDL	BDL	BDL	BDL	26.6	145	2310	BDL	BDL

Upper Animas River High-Flow
Raw Data

Site #	Description	Sample Time	Flow Time	Adjusted Flow cfs	pH s.u.	Cond. umhos/cm	Temp. Deg C	Tot. Al ug/l	Tot. Ba ug/l	Tot. Be ug/l	Tot. Co ug/l	Tot. Cr ug/l	Tot. Cu ug/l	Tot. Fe ug/l	Tot. Mn ug/l	Tot. Ni ug/l	Tot. Sb ug/l
BG-3	Burrows Creek below London Mine	1442	1040	2.828	4.28	135	14	2920	BDL	BDL	BDL	BDL	39	137	2140	BDL	BDL
BG-4	Burrows Creek above Large Fault	1430	1055	4.027	4.31	108	13	2380	BDL	BDL	BDL	BDL	33.4	112	1660	BDL	BDL
BG-5	Burrows Creek above Animas	1625	1045	3.99	4.57	103	9	2400	BDL	BDL	BDL	BDL	30.9	85.6	1660	BDL	BDL
BG-7	Duplicate of BG-3, metals & BG-4 anions	1442		2.828				3200	BDL	BDL	BDL	BDL	41.6	108	2310	BDL	BDL
LJ-1	Animas below Lucky Jack Mine	1515	1208	0.576	6.1	63	14	137	BDL	BDL	BDL	BDL	6.04	227	115	BDL	BDL
HC-1	Horseshoe Creek	1505	1140	5.174	7.01	32	10	BDL	BDL	BDL	BDL	BDL	4.12	118	5.37	20.1	BDL
PL-1	Placer Gulch	1445	1045	23.294	6.96	67	9	412	BDL	BDL	BDL	BDL	32	144	1290	BDL	54.3
CN-1	Cinnamon Creek	1630	1255	23.789	7.06	330	7	1400	BDL	BDL	BDL	BDL	4.56	1680	126	BDL	BDL
GG-1	Grouse Gulch	1645	1335	23.160	6.55	98	6	BDL	BDL	BDL	BDL	BDL	BDL	61.8	7.41	BDL	BDL
PY-1	Picayune Gulch	1610	1615	16.944	7.18	96	9	112	BDL	BDL	BDL	BDL	BDL	101	56.1	BDL	BDL
BU-1	Burns Gulch	1640	1040	15.678	6.85	67	6	65.9	BDL	BDL	BDL	BDL	22.3	44.1	109	BDL	BDL
NG-1	Niagra Gulch	1515	1300	3.689	6.76	59	8	BDL	BDL	BDL	BDL	BDL	BDL	25.1	BDL	BDL	BDL
DM-1	Unknown Prospect Above Denver Lake			0.004	4.13	134	11	539	BDL	BDL	BDL	BDL	36.4	4180	108	24.1	BDL
DM-2	Lucky Jack Mine Drainage			0.005	3.94	289	8	1350	BDL	BDL	BDL	BDL	78.8	2550	493	BDL	BDL
DM-4	Early Bird Mine Drainage			0.034	4.4	231	8	4980	BDL	BDL	BDL	BDL	379	2000	2150	BDL	BDL
DM-5	Draining Mine near London Mine-West			0.013	7.3	75	13	BDL	BDL	BDL	BDL	BDL	40.3	388	10	BDL	BDL
DM-6	Draining Mine near London Mine-East			0.0072	5.73	97	10	74.9	BDL	BDL	BDL	BDL	30.8	433	113	BDL	BDL
DM-7	London Mine Drainage			0.0025	8.08	341	11	1100	BDL	BDL	BDL	BDL	222	8830	1500	BDL	BDL
DM-8	Prairie Mine Drainage			0.005	7.2	59	11	745	BDL	BDL	BDL	BDL	8.43	352	105	BDL	BDL
DM-10	Mountain Queen Adit Drainage			0.0252	3.9	188	1	1730	BDL	BDL	BDL	BDL	674	3070	1490	BDL	BDL
DM-11	Little Ida Mine Drainage - Upper Adit			0.03	6.25	18	ND	78.1	BDL	BDL	BDL	BDL	15.6	205	10.5	BDL	BDL
DM-13	Little Ida Mine Drainage - Middle Adit			0.004	5.9	20	1	708	BDL	BDL	BDL	BDL	128	171	239	BDL	BDL
DM-14	Little Ida Mine Drainage - Lower Adit			0.005	6.54	54		104	BDL	BDL	BDL	BDL	20.1	27.1	60.3	BDL	BDL
DM-15	Burrows Mine Drainage - West			0.005	4.65	70	ND	460	BDL	BDL	BDL	BDL	71.4	48.1	391	BDL	BDL
DM-16	Burrows Mine Drainage - East			0.005	4.94	117	ND	1160	BDL	BDL	BDL	BDL	41.5	69.9	550	BDL	BDL
DM-17	Vermillion Mine Drainage			0.067	3.74	293		1000	BDL	BDL	BDL	BDL	459	5190	3180	BDL	BDL
DM-18	Vermillion Tunnel Mine Drainage			0.13	6.01	433	ND	63.3	BDL	BDL	BDL	BDL	4.49	383	741	BDL	BDL
DM-19	Bagley Tunnel Drainage			0.116	5.3	620	10	218	BDL	BDL	BDL	BDL	4.94	609	6940	BDL	BDL
DM-20	Columbus Mine Drainage			0.0113	2.88	1563	11	9230	BDL	BDL	102	BDL	4880	38200	6010	43.6	BDL
DM-21	Silver Wing Mine Drainage			0.021	6.77	742	15	790	BDL	BDL	BDL	BDL	1660	10800	3340	BDL	BDL
DM-22	Tom Moore Mine Drainage			0.101	7.62	117	13	59	BDL	BDL	BDL	BDL	4.1	131	674	BDL	BDL
DM-24	Senator Mine Drainage			0.191	6.7	1362	15	515	BDL	BDL	BDL	BDL	BDL	20500	7230	38.7	BDL
DM-25	Silver Queen Mine Drainage			0.0088	3.38	331	6	670	BDL	BDL	BDL	BDL	1050	15100	11900	BDL	BDL
DM-26	Sound Democrat Mine Drainage			0.2064	4.76	135	3	2610	BDL	BDL	BDL	BDL	83.4	4100	4050	BDL	BDL
DM-27	Golden Fleece Mine Drainage			0.0212	3.49	280	8	2260	BDL		BDL	BDL	41.3	3990	4820	BDL	BDL
DM-28	Indian Chief Mine Drainage			0.083	5.9	61	ND	BDL	BDL	BDL	BDL	BDL	BDL	77.8	111	BDL	BDL
DM-29	Toltec Mine Drainage			0.021	8.36	41	11	122	BDL	BDL	BDL	BDL	31.8	639	298	BDL	BDL
DM-30	Unknown Draining Mine South of Grouse Gulch			0.0028	6.94	172	10	162	BDL	BDL	BDL	BDL	8.64	215	114	BDL	BDL
DM-31	Duplicate of DM-19			0.116				92.1	BDL	BDL	BDL	BDL	BDL	584	7250	BDL	BDL
DM-32	Duplicate of DM29			0.021				313	BDL	BDL	BDL	BDL	67.9	957	706	BDL	BDL

Upper Animas River High-Flow
Raw Data

Site #	Description	Tot. Va	Tot.Zn	Tot. Ca	Tot. Mg	Tot. Na	Tot. K	Tot. Ag	Tot. As	Tot. Cd	Tot. Pb	Tot. Se	Tot. Th	Diss. Al	Diss. Ba	Diss. Be	Diss. Co	Diss. Cr	Diss. Cu
		ug/l	ug/l	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
UA-1	Animas above Denver Lake	BDL	BDL	9.02	BDL	2.09	BDL	4.1	BDL	0.5	7.39	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-2	Animas above Lucky Jack Mine	BDL	15.5	6.960	BDL	2.32	BDL	BDL	BDL	0.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-3	Animas above Horseshoe Creek	BDL	BDL	7.31	BDL	1.95	BDL	2.02	BDL	BDL	5.45	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-4	Animas below Burrows Creek	BDL	339	7.49	BDL	1.98	BDL	2.03	BDL	3.37	7.1	BDL	BDL	77.2	BDL	BDL	BDL	BDL	5.44
UA-5	Animas below mining complex	BDL	303	7.23	1.02	2.13	BDL	6.09	BDL	2.92	6.99	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-6a	Animas above Cal Gulch	BDL	279	6.95	BDL	2.17	BDL	1.22	BDL	2.81	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.7
UA-6b	Animas above Cal Gulch	BDL	255	6.86	BDL	1.94	BDL	0.81	BDL	2.68	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-6c	Animas above Cal Gulch	BDL	261	6.49	BDL	1.56	BDL	BDL	BDL	2.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-6d	Animas above Cal Gulch	BDL	269	6.45	BDL	1.45	BDL	0.81	BDL	2.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.26
UA-6e	Animas above Cal Gulch	BDL	289	7.29	BDL	1.71	BDL	BDL	BDL	2.9	7.56	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.09
UA-6f	Animas above Cal Gulch	BDL	279	6.95	BDL	2.17	BDL	1.22	BDL	2.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-7	Animas below California Gulch	BDL	539	11.4	1.5	1.72	BDL	3.05	BDL	2.91	12.70	BDL	BDL	193	BDL	BDL	BDL	BDL	7.5
UA-11	Animas above Niagra Gulch	BDL	301	13.8	1.35	1.87	BDL	1.85	BDL	2.14	8.23	BDL	BDL	56.3	BDL	BDL	BDL	BDL	BDL
UA-12a	Animas above Eureka Gulch 1020	BDL	305	13.5	1.32	2.15	BDL	2.01	BDL	2.08	5.56	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.64
UA-12b	Animas above Eureka Gulch	BDL	305	13.2	1.3	1.98	BDL	3.45	BDL	2.04	5.62	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-12c	Animas above Eureka Gulch	BDL	281	13.2	1.27	2.07	BDL	2.36	BDL	2.03	6.36	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.65
UA-12d	Animas above Eureka Gulch	BDL	290	13.9	1.34	1.92	BDL	2.37	BDL	2.13	5.8	BDL	BDL	51.4	BDL	BDL	BDL	BDL	BDL
UA-12e	Animas above Eureka Gulch	BDL	276	13.50	1.32	1.76	BDL	1.51	BDL	2.07	6.56	BDL	BDL	53.1	BDL	BDL	BDL	BDL	5.34
UA-12f	Animas above Eureka Gulch	BDL	332	13.60	1.32	1.77	BDL	3.92	BDL	2.23	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.15
CG-1	California Gulch Above Mtn. Queen	BDL	157	7.53	BDL	1.65	BDL	3.59	BDL	1.15	BDL	BDL	BDL	101	BDL	BDL	BDL	BDL	8.31
CG-2	California Gulch below Mtn. Queen	BDL	191	20	2.35	1.93	BDL	1.01	BDL	1.39	43.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.14
CG-3	Cal Gulch above DM-11-16	BDL	838	15.6	2.64	2.06	BDL	1.34	BDL	4.01	21.4	BDL	BDL	1710	BDL	BDL	BDL	BDL	13.5
CG-4	Cal Gulch below DM-11-16	BDL	731	14.6	2.55	2.15	BDL	1.02	BDL	3.53	22.2	BDL	BDL	1340	BDL	BDL	BDL	BDL	11.5
CG-5	Tributary below DM-17	BDL	1680	4.43	BDL	BDL	BDL	1.63	BDL	9.21	55.5	BDL	BDL	546	BDL	BDL	BDL	BDL	69.4
CG-6	Cal Gulch below DM-17 tributary	BDL	772	13.90	2.16	BDL	BDL	1.58	BDL	3.88	19.5	BDL	BDL	1230	BDL	BDL	BDL	BDL	13.5
CG-7	Cal Gulch above Placer Gulch	BDL	678	14.10	2.29	2.05	BDL	1.88	BDL	3.37	20	BDL	BDL	1170	BDL	BDL	BDL	BDL	12.1
CG-8	Cal Gulch below Placer Gulch	BDL	653	13.20	1.92	1.94	BDL	0.9	BDL	2.97	25.7	BDL	BDL	451	BDL	BDL	BDL	BDL	12.6
CG-9	Cal Gulch below Bagley Mine Drainage	BDL	630	1209	1.71	1.94	BDL	2.75	BDL	2.87	17.6	BDL	BDL	430	BDL	BDL	BDL	BDL	12.6
CG-10	Cal Gulch below Bagley Mill Tailings	BDL	615	12.7	1.61	1.85	BDL	BDL	BDL	2.73	18.40	BDL	BDL	354	BDL	BDL	BDL	BDL	11.7
CG-11	Cal Gulch above Columbus Mine	BDL	625	12.7	1.58	1.89	BDL	1.94	BDL	2.74	17.7	BDL	BDL	329	BDL	BDL	BDL	BDL	10.6
CG-12a	Cal Gulch at Mouth	BDL	743	13.4	1.68	2	BDL	3.13	BDL	3.1	6.27	BDL	BDL	402	BDL	BDL	BDL	BDL	15.1
CG-12b	Cal Gulch at Mouth	BDL	702	12.8	1.62	1.65	BDL	2.43	BDL	3.08	9.18	BDL	BDL	398	BDL	BDL	BDL	BDL	15
CG-12c	Cal Gulch at Mouth	BDL	724	13.9	1.72	2.04	BDL	0.95	BDL	3.18	7.33	BDL	BDL	392	BDL	BDL	BDL	BDL	14.7
CG-12d	Cal Gulch at Mouth	BDL	690	13.3	1.64	1.88	BDL	BDL	BDL	3.04	8.59	BDL	BDL	392	BDL	BDL	BDL	BDL	14.2
CG-12e	Cal Gulch at Mouth	BDL	661	12.7	1.64	1.97	BDL	0.95	BDL	2.99	11.1	BDL	BDL	380	BDL	BDL	BDL	BDL	13.5
CG-12f	Cal Gulch at Mouth	BDL	608	12.6	1.64	2.95	BDL	1.5	BDL	2.86	21.8	BDL	BDL	339	BDL	BDL	BDL	BDL	12.3
CG-13	Duplicate of CG-4 metals & CG-3 Anions	BDL	14.3	1.56	BDL	1.9	BDL	BDL	B	BDL	BDL	BDL	BDL	1220	BDL	BDL	BDL	BDL	9.32
BG-2	Burrows Creek above London Mine	BDL	3290	8.2	BDL	BDL	BDL	3.98	BDL	19.4	18.9	BDL	BDL	5470	BDL	BDL	BDL	BDL	27.1

Upper Animas River High-Flow
Raw Data

Site #	Description	Tot. Va	Tot.Zn	Tot. Ca	Tot. Mg	Tot. Na	Tot. K	Tot. Ag	Tot. As	Tot. Cd	Tot. Pb	Tot. Se	Tot. Th	Diss. Al	Diss. Ba	Diss. Be	Diss. Co	Diss. Cr	Diss. Cu
		ug/l	ug/l	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
BG-3	Burrows Creek below London Mine	BDL	1410	9.36	1.57	2.4	BDL	7.77	BDL	11.80	5.72	BDL	BDL	3750	BDL	BDL	BDL	BDL	45.8
BG-4	Burrows Creek above Large Fault	BDL	1120	8.12	1.31	1.63	BDL	2.07	BDL	9.75	13.1	BDL	BDL	2750	BDL	BDL	BDL	BDL	33.5
BG-5	Burrows Creek above Animas	BDL	1160	8.54	1.36	1.85	BDL	BDL	BDL	8.81	20.30	BDL	BDL	2560	BDL	BDL	BDL	BDL	31.9
BG-7	Duplicate of BG-3, metals & BG-4 anions	BDL	1550	9.77	1.65	1.85	BDL	1.12	BDL	12.00	5.04	BDL	BDL	3640	BDL	BDL	BDL	BDL	42.3
LJ-1	Animas below Lucky Jack Mine	BDL	453	7.93	1.02	2.4	BDL	BDL	BDL	4.92	BDL	BDL	BDL	89.9	BDL	BDL	BDL	BDL	BDL
HC-1	Horseshoe Creek	BDL	59.7	5.57	BDL	BDL	BDL	1.55	BDL	0.55	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
PL-1	Placer Gulch	BDL	558	10.9	1.15	2.38	BDL	5.52	BDL	2.26	15.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13.2
CN-1	Cinnamon Creek	BDL	BDL	11.8	1.38	BDL	BDL	3.39	BDL	BDL	6.79	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GG-1	Grouse Gulch	BDL	BDL	14.9	1.02	1.69	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
PY-1	Picayune Gulch	BDL	BDL	15.4	1.4	2.21	BDL	2.27	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BU-1	Bums Gulch	BDL	596	11.8	BDL	1.89	BDL	2.97	BDL	5.77	15.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	20.3
NG-1	Niagra Gulch	BDL	BDL	9.8	BDL	1.42	BDL	1.63	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-1	Unknown Prospect Above Denver Lake	BDL	2080	8.01	1.13	2	BDL	2.14	BDL	16.60	467	BDL	BDL	237	BDL	BDL	BDL	BDL	33
DM-2	Lucky Jack Mine Drainage	BDL	4200	12.8	1.61	2.28	BDL	1630	BDL	25.1	348	BDL	BDL	1230	BDL	BDL	BDL	BDL	82.4
DM-4	Early Bird Mine Drainage	BDL	1320	9.76	2.88	1.8	1.21	0.97	BDL	17	28.2	BDL	BDL	5360	BDL	BDL	BDL	BDL	397
DM-5	Draining Mine near London Mine-West	BDL	749	13.5	BDL	2.66	BDL	BDL	BDL	4.96	67.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	31.9
DM-6	Draining Mine near London Mine-East	BDL	1350	9.19	BDL	2.16	BDL	6.01	BDL	8.35	132	BDL	BDL	BDL	BDL	BDL	BDL	BDL	32.2
DM-7	London Mine Drainage	BDL	7810	48.2	3.36	6.29	1.24	2.17	22.3	51.7	85.4	1.96	BDL	BDL	BDL	BDL	BDL	BDL	11.2
DM-8	Prairie Mine Drainage	BDL	694	13	BDL	2.36	1.00	0.80	BDL	3.67	30.10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-10	Mountain Queen Adit Drainage	BDL	1980	9.19	1.15	1.94	BDL	BDL	BDL	19.1	68.5	BDL	BDL	1790	BDL	BDL	BDL	BDL	696
DM-11	Little Ida Mine Drainage - Upper Adit	BDL	547	3.08	BDL	1.66	BDL	BDL	BDL	4.17	68.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12.4
DM-13	Little Ida Mine Drainage - Middle Adit	BDL	1940	6.73	BDL	2.21	BDL	0.92	BDL	10.9	202	BDL	BDL	72.7	BDL	BDL	BDL	BDL	16.8
DM-14	Little Ida Mine Drainage - Lower Adit	BDL	356	3.83	BDL	2.02	BDL	BDL	BDL	2.37	137	BDL	BDL	602	BDL	BDL	BDL	BDL	129
DM-15	Burrows Mine Drainage - West	BDL	3610	6.43	BDL	1.93	BDL	BDL	BDL	19.5	616	BDL	BDL	458	BDL	BDL	BDL	BDL	68.6
DM-16	Burrows Mine Drainage - East	BDL	7940	16.1	1.31	2.16	BDL	0.88	BDL	30.6	12.3	BDL	BDL	110	BDL	BDL	BDL	BDL	28.1
DM-17	Vermillion Mine Drainage	BDL	22600	7.02	BDL	1.67	BDL	9.13	BDL	1.06	2540	BDL	BDL	973	BDL	BDL	BDL	BDL	495
DM-18	Vermillion Tunnel Mine Drainage	BDL	782	80.7	5.03	5.41	1.48	BDL	BDL	2.71	6.29	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-19	Bagley Tunnel Drainage	BDL	3690	112	7.24	5.92	2.76	BDL	BDL	7.44	8.05	BDL	BDL	92.5	BDL	BDL	BDL	BDL	BDL
DM-20	Columbus Mine Drainage	BDL	126000	13.6	4.33	1.79	BDL	490	14.9	625	592	BDL	BDL	10000	BDL	BDL	119	BDL	5270
DM-21	Silver Wing Mine Drainage	BDL	3190	114	4.7	5.37	1.35	0.95	21.3	11.7	30.1	BDL	BDL	159	BDL	BDL	BDL	BDL	178
DM-22	Tom Moore Mine Drainage	BDL	704	66	1.95	3.67	BDL	BDL	BDL	2.25	7.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-24	Senator Mine Drainage	BDL	458	234	21.6	7.82	2.38	BDL	BDL	0.59	6.33	BDL	BDL	284	BDL	BDL	BDL	BDL	BDL
DM-25	Silver Queen Mine Drainage	BDL	2840	29.8	1.85	2.06	BDL	601	20.7	11.2	240	BDL	BDL	585	BDL	BDL	BDL	BDL	1050
DM-26	Sound Democrat Mine Drainage	BDL	804	24.3	2.16	2.18	1.3	444	BDL	2.8	52	BDL	BDL	297	BDL	BDL	BDL	BDL	62.5
DM-27	Golden Fleece Mine Drainage	BDL	492	11.6	1.57	1.65	BDL	488	BDL	3.73	26.1	BDL	BDL	2450	BDL	BDL	BDL	BDL	43.5
DM-28	Indian Chief Mine Drainage	BDL	46.8	10.1	BDL	2.01	BDL	1.11	BDL	0.67	16.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-29	Toltec Mine Drainage	BDL	78.5	52.7	6.35	5.21	1.38	BDL	BDL	0.64	16.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.17
DM-30	Unknown Draining Mine South of Grouse Gulch	BDL	107	31.4	2.14	3.27	BDL	1.84	BDL	BDL	12.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-31	Duplicate of DM-19	BDL	3990	115.000	7.35	5.85	2.68	BDL	BDL	8.34	BDL	BDL	BDL	97.8	BDL	BDL	BDL	BDL	BDL
DM-32	Duplicate of DM29	BDL	343	52.300	6.29	5.04	1.44	BDL	BDL	1.4	31.70	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Upper Animas River High-Flow
Raw Data

Site #	Description	Diss. Fe	Diss. Mn	Diss. Ni	Diss. Sb	Diss. Va	Diss. Zn	Diss. Ca	Diss. Mg	Diss. Na	Diss. K	Diss. As	Diss. Cd	Diss. Pb	Diss. Se	Diss. Ag	Diss. Th	Cl	SO4
		ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l
UA-1	Animas above Denver Lake	76.4	24.9	BDL	BDL	BDL	BDL	9.75	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.55	21.9
UA-2	Animas above Lucky Jack Mine	BDL	B	BDL	BDL	BDL	BDL	6.560	BDL	BDL	BDL	BDL	0.67	BDL	BDL	BDL	BDL	0.45	2.8
UA-3	Animas above Horseshoe Creek	51.8	11.8	BDL	BDL	BDL	BDL	6.86	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.45	12.6
UA-4	Animas below Burrows Creek	18.1	519	BDL	BDL	BDL	309	6.56	BDL	BDL	BDL	BDL	3.54	BDL	BDL	BDL	BDL	BDL	20.6
UA-5	Animas below mining complex	10.6	438	BDL	BDL	BDL	278	6.47	BDL	BDL	BDL	BDL	3.12	BDL	BDL	BDL	BDL	BDL	20.5
UA-6a	Animas above Cal Gulch	BDL	426	BDL	BDL	BDL	320	6.71	BDL	BDL	BDL	BDL	2.68	BDL	BDL	BDL	BDL		
UA-6b	Animas above Cal Gulch	BDL	425	BDL	BDL	BDL	327	7.26	BDL	BDL	BDL	BDL	2.68	BDL	BDL	BDL	BDL		
UA-6c	Animas above Cal Gulch	BDL	417	BDL	BDL	BDL	328	6.81	BDL	BDL	BDL	BDL	2.69	BDL	BDL	BDL	BDL		
UA-6d	Animas above Cal Gulch	BDL	413	BDL	BDL	BDL	328	6.84	BDL	BDL	BDL	BDL	2.68	BDL	BDL	BDL	BDL	0.45	28.4
UA-6e	Animas above Cal Gulch	BDL	410	BDL	BDL	BDL	322	6.72	BDL	BDL	BDL	BDL	2.69	BDL	BDL	BDL	BDL		
UA-6f	Animas above Cal Gulch	12	408	BDL	BDL	BDL	322	6.57	BDL	BDL	BDL	BDL	2.74	BDL	BDL	BDL	BDL		
UA-7	Animas below California Gulch	12	1860	BDL	BDL	BDL	503	11.5	1.47	BDL	BDL	BDL	3.08	BDL	BDL	BDL	BDL	BDL	38.4
UA-11	Animas above Niagra Gulch	BDL	863	BDL	BDL	BDL	295	13.3	1.32	BDL	BDL	BDL	2.24	BDL	BDL	BDL	BDL	BDL	30.8
UA-12a	Animas above Eureka Gulch 1020	BDL	838	BDL	BDL	BDL	265	13.1	1.31	BDL	BDL	BDL	2.25	BDL	BDL	BDL	BDL		
UA-12b	Animas above Eureka Gulch	BDL	836	BDL	BDL	BDL	257	13.1	1.3	BDL	BDL	BDL	2.29	BDL	BDL	BDL	BDL		
UA-12c	Animas above Eureka Gulch	BDL	845	BDL	BDL	BDL	256	13.2	1.33	BDL	BDL	BDL	2.21	BDL	BDL	BDL	BDL		
UA-12d	Animas above Eureka Gulch	BDL	841	BDL	BDL	BDL	239	13.2	1.32	BDL	BDL	BDL	2.22	BDL	BDL	BDL	BDL		
UA-12e	Animas above Eureka Gulch	BDL	886	BDL	BDL	BDL	306	13.60	1.32	BDL	BDL	BDL	2.21	BDL	BDL	BDL	BDL	0.55	41.1
UA-12f	Animas above Eureka Gulch	BDL	908	BDL	BDL	BDL	321	13.60	1.32	BDL	BDL	BDL	2.31	BDL	BDL	BDL	BDL		
CG-1	California Gulch Above Mtn. Queen	BDL	154	BDL	BDL	BDL	113	7.16	BDL	BDL	BDL	BDL	1.13	BDL	BDL	BDL	BDL	BDL	21.7
CG-2	California Gulch below Mtn. Queen	BDL	145	BDL	BDL	BDL	115.00	19.9	2.03	BDL	1.03	BDL	1.08	BDL	BDL	0.36	BDL	BDL	52.1
CG-3	Cal Gulch above DM-11-16	BDL	4930	BDL	BDL	BDL	803.00	15.4	2.44	BDL	BDL	BDL	3.84	BDL	BDL	BDL	BDL	BDL	65.5
CG-4	Cal Gulch below DM-11-16	13.6	4210	BDL	BDL	BDL	714	14.5	2.24	BDL	BDL	BDL	3.38	BDL	BDL	BDL	BDL	BDL	61.7
CG-5	Tributary below DM-17	127	481	BDL	BDL	BDL	1640	3.66	BDL	BDL	BDL	BDL	8.56	54.2	BDL	BDL	BDL	BDL	25.8
CG-6	Cal Gulch below DM-17 tributary	24.1	3880	BDL	BDL	BDL	767	13.60	2.1	BDL	BDL	BDL	3.68	BDL	BDL	0.46	BDL	BDL	57.5
CG-7	Cal Gulch above Placer Gulch	23	3850	BDL	BDL	BDL	1020	15.60	2.13	BDL	BDL	BDL	3.34	BDL	BDL	BDL	BDL	BDL	56.4
CG-8	Cal Gulch below Placer Gulch	18.9	2580	BDL	BDL	BDL	630	12.70	1.7	BDL	BDL	BDL	2.8	BDL	BDL	BDL	BDL	BDL	49.6
CG-9	Cal Gulch below Bagley Mine Drainage	31.8	2530	BDL	BDL	BDL	363	13	1.71	BDL	BDL	BDL	2.74	BDL	BDL	BDL	BDL	BDL	41.5
CG-10	Cal Gulch below Bagley Mill Tailings	15.7	2400	BDL	BDL	BDL	622	12.7	1.67	BDL	BDL	BDL	2.71	BDL	BDL	BDL	BDL	1.15	46.4
CG-11	Cal Gulch above Columbus Mine	12.9	2350	BDL	BDL	BDL	599	12.5	1.64	BDL	BDL	BDL	2.71	BDL	BDL	BDL	BDL	BDL	51.3
CG-12a	Cal Gulch at Mouth	25	2770	BDL	BDL	BDL	757	14.1	1.84	BDL	BDL	BDL	3.51	BDL	BDL	BDL	BDL		
CG-12b	Cal Gulch at Mouth	22.3	2760	BDL	BDL	BDL	748	14.1	1.84	BDL	BDL	BDL	3.12	BDL	BDL	0.38	BDL		
CG-12c	Cal Gulch at Mouth	22.4	2810	BDL	BDL	BDL	751	14.4	1.85	BDL	BDL	BDL	3.11	BDL	BDL	0.42	BDL		
CG-12d	Cal Gulch at Mouth	23.2	2750	BDL	BDL	BDL	759	14.2	1.84	BDL	BDL	BDL	3.22	BDL	BDL	BDL	BDL	BDL	61.3
CG-12e	Cal Gulch at Mouth	17	2640	BDL	BDL	BDL	702	13.6	1.76	BDL	BDL	BDL	2.97	BDL	BDL	BDL	BDL		
CG-12f	Cal Gulch at Mouth	16.2	2490	BDL	BDL	BDL	690	13.3	1.7	BDL	BDL	BDL	2.87	BDL	BDL	BDL	BDL		
CG-13	Duplicate of CG-4 metals & CG-3 Anions	BDL	4190	BDL	BDL	BDL	720	14.8	2.21	BDL	BDL	BDL	3.22	BDL	BDL	BDL	BDL	BDL	63.4
BG-2	Burrows Creek above London Mine	128	2420	BDL	BDL	BDL	3400	8.41	1.05	BDL	BDL	BDL	19.2	11.5	BDL	BDL	BDL	BDL	71

Upper Animas River High-Flow
Raw Data

Site #	Description	Diss. Fe	Diss. Mn	Diss. Ni	Diss. Sb	Diss. Va	Diss. Zn	Diss. Ca	Diss. Mg	Diss. Na	Diss. K	Diss. As	Diss. Cd	Diss. Pb	Diss. Se	Diss. Ag	Diss. Th	Cl	SO4
		ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l
BG-3	Burrows Creek below London Mine	103	2470	BDL	BDL	BDL	1600	10.3	1.87	BDL	BDL	BDL	12.3	BDL	BDL	BDL	BDL	BDL	68.9
BG-4	Burrows Creek above Large Fault	79.8	1770	BDL	BDL	BDL	1180	8.39	1.49	BDL	BDL	BDL	9.68	12.2	BDL	BDL	BDL	BDL	50.6
BG-5	Burrows Creek above Animas	62	1650	BDL	BDL	BDL	1110	8.04	1.4	BDL	BDL	BDL	8.89	11.90	BDL	BDL	BDL	BDL	47.8
BG-7	Duplicate of BG-3, metals & BG-4 anions	94.8	2460	BDL	BDL	BDL	1640	10.2	1.86	BDL	BDL	BDL	12.9	BDL	BDL	BDL	BDL	BDL	78.1
LJ-1	Animas below Lucky Jack Mine	62.7	122	BDL	BDL	BDL	420	7.91	1.09	BDL	BDL	BDL	4.76	BDL	BDL	BDL	BDL	0.95	19.6
HC-1	Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	5.43	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.65	7.6
PL-1	Placer Gulch	27.9	1440	BDL	BDL	BDL	589.0	12.1	1.34	BDL	BDL	BDL	2.28	BDL	BDL	BDL	BDL	0.65	32.4
CN-1	Cinnamon Creek	13.6	4.19	BDL	BDL	BDL	BDL	11.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.56	12.6
GG-1	Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	15.8	1.05	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.65	20.3
PY-1	Picayune Gulch	11.8	37.6	BDL	BDL	BDL	11.6	15.9	1.47	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.85	12.7
BU-1	Burns Gulch	BDL	108	BDL	BDL	BDL	605	11.4	BDL	BDL	BDL	BDL	5.39	9.54	BDL	BDL	BDL	0.75	24.6
NG-1	Niagra Gulch	BDL	BDL	BDL	BDL	BDL	BDL	10.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.65	27.9
DM-1	Unknown Prospect Above Denver Lake	2040	108	BDL	BDL	BDL	2240	7.78	1.1	BDL	BDL	BDL	17.2	361	BDL	0.5	BDL	BDL	40.6
DM-2	Lucky Jack Mine Drainage	1950	577	BDL	BDL	BDL	5000	13.7	1.74	BDL	BDL	BDL	28.9	262	BDL	0.41	BDL	BDL	59.6
DM-4	Early Bird Mine Drainage	2090	2280	BDL	BDL	BDL	1350	10	3.02	BDL	1.2	BDL	17.60	26.3	BDL	0.58	BDL	0.95	94.1
DM-5	Draining Mine near London Mine-West	197	8.61	BDL	BDL	BDL	750	13.5	BDL	1	BDL	BDL	5.37	31.1	BDL	BDL	BDL	1.96	20.9
DM-6	Draining Mine near London Mine-East	264	116	BDL	BDL	BDL	1400	8.54	BDL	BDL	BDL	BDL	8.97	103	BDL	BDL	BDL	1.58	25.8
DM-7	London Mine Drainage	385	1200	BDL	BDL	BDL	7580	51	3.52	5.25	1.2	BDL	49.6	BDL	BDL	BDL	BDL	2.46	131
DM-8	Prairie Mine Drainage	BDL	7.53	BDL	BDL	BDL	542	12.5	BDL	BDL	BDL	BDL	3.26	BDL	BDL	BDL	BDL	1.15	19.9
DM-10	Mountain Queen Adit Drainage	2580	1560	BDL	BDL	BDL	1990	9.09	1.18	BDL	BDL	BDL	19.2	64	BDL	0.53	BDL	BDL	51.3
DM-11	Little Ida Mine Drainage - Upper Adit	106	10	BDL	BDL	BDL	491	2.84	BDL	BDL	BDL	BDL	4.32	338	BDL	BDL	BDL	0.65	9.1
DM-13	Little Ida Mine Drainage - Middle Adit	BDL	60.5	BDL	BDL	BDL	314	3.47	BDL	BDL	BDL	BDL	2.38	131	BDL	BDL	BDL	0.55	8.4
DM-14	Little Ida Mine Drainage - Lower Adit	34.5	246	BDL	BDL	BDL	1990	6.76	BDL	BDL	BDL	BDL	12.1	211	BDL	0.38	BDL	BDL	23.9
DM-15	Burrows Mine Drainage - West	10.3	420	BDL	BDL	BDL	3870	6.55	BDL	BDL	BDL	BDL	21	737	BDL	BDL	BDL	BDL	29.8
DM-16	Burrows Mine Drainage - East	47	566	BDL	BDL	BDL	8490	17.3	1.37	BDL	BDL	BDL	30.40	7.61	BDL	BDL	BDL	0.75	55.5
DM-17	Vermillion Mine Drainage	5640	3450	BDL	BDL	BDL	25000	6.96	BDL	BDL	BDL	BDL	111	2960	BDL	1.97	BDL	BDL	99.7
DM-18	Vermillion Tunnel Mine Drainage	BDL	749	BDL	BDL	BDL	734.0	86.4	5.33	4.27	1.48	BDL	2.42	BDL	BDL	BDL	BDL	1.25	143
DM-19	Bagley Tunnel Drainage	151	7270	BDL	BDL	BDL	4060	119	7.52	4.88	2.79	BDL	7.44	BDL	BDL	BDL	BDL	1.45	278
DM-20	Columbus Mine Drainage	41500	6480	23.8	BDL	BDL	142000	13.8	4.71	BDL	BDL	BDL	88.7	843	BDL	0.67	BDL	BDL	500
DM-21	Silver Wing Mine Drainage	4180	3500	BDL	BDL	BDL	3250	124	4.99	4.45	1.86	BDL	12.6	BDL	BDL	BDL	BDL	0.85	269
DM-22	Tom Moore Mine Drainage	BDL	605	BDL	BDL	BDL	650	70.7	2.04	3.11	1.1	BDL	2.09	BDL	BDL	BDL	BDL	0.75	86
DM-24	Senator Mine Drainage	20500	7210	BDL	BDL	BDL	403	236	22.4	7.01	3.71	BDL	BDL	BDL	BDL	BDL	BDL	1.86	633
DM-25	Silver Queen Mine Drainage	7540	11900	BDL	BDL	BDL	2780	30.3	1.84	BDL	BDL	BDL	11.5	89.2	BDL	0.72	BDL	BDL	142
DM-26	Sound Democrat Mine Drainage	33.6	3980	BDL	BDL	BDL	728	24.3	1.7	BDL	BDL	BDL	2.88	BDL	BDL	BDL	BDL	0.45	80.2
DM-27	Golden Fleece Mine Drainage	4230	5090	BDL	BDL	BDL	508	11.8	1.63	BDL	BDL	BDL	3.94	22	BDL	0.33	BDL	BDL	90
DM-28	Indian Chief Mine Drainage	10.6	67.4	BDL	BDL	BDL	25.9	10.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.85	24
DM-29	Toltec Mine Drainage	32.8	27.5	BDL	BDL	BDL	101	53	6.44	4.2	1.37	BDL	BDL	BDL	BDL	BDL	BDL	1.05	67.1
DM-30	Unknown Draining Mine South of Grouse Gulch	BDL	97.4	BDL	BDL	BDL	96.60	32.1	2.12	1.84	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.15	43.4
DM-31	Duplicate of DM-19	144	7190	BDL	BDL	BDL	4000.00	118.000	7.59	5.06	2.86	BDL	7.8	BDL	BDL	BDL	BDL	0.85	275
DM-32	Duplicate of DM29	BDL	16.6	BDL	BDL	BDL	BDL	52.500	6.36	4.25	1.36	BDL	BDL	BDL	BDL	BDL	BDL	0.95	65.6

Upper Animas High-Flow
Loading Data

Site #	Description	Tot. Ag	Diss. Ag	Tot. Al	Diss. Al	Tot. As	Diss. As	Tot. Ba	Diss. Ba	Tot. Be	Diss. Be	Tot. Cd	Diss. Cd	Tot. Co
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
UA-1	Animas above Denver Lake	6.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.8	BDL	BDL
UA-2	Animas above Lucky Jack Mine	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.8	0.8	BDL
UA-3	Animas above Horseshoe Creek	10.0	BDL	458.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-4	Animas below Burrows Creek	74.0	BDL	30139.4	2813.5	BDL	BDL	BDL	BDL	BDL	BDL	122.8	129.0	BDL
UA-5	Animas below mining complex	263.7	BDL	29655.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	126.4	135.1	BDL
UA-6a	Animas above Cal Gulch	59.8	BDL	28026.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	137.7	131.3	BDL
UA-6b	Animas above Cal Gulch	33.0	BDL	21124.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	109.3	109.3	BDL
UA-6c	Animas above Cal Gulch	BDL	BDL	21994.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	111.6	112.5	BDL
UA-6d	Animas above Cal Gulch	39.1	BDL	26252.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	140.9	129.3	BDL
UA-6e	Animas above Cal Gulch	BDL	BDL	27207.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	135.3	125.5	BDL
UA-6f	Animas above Cal Gulch	59.7	BDL	27989.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	137.5	134.1	BDL
UA-7	Animas below California Gulch	492.5	BDL	185697.8	31164.9	BDL	BDL	BDL	BDL	BDL	BDL	469.9	497.3	BDL
UA-11	Animas above Niagra Gulch	481.7	BDL	106235.5	14659.5	BDL	BDL	BDL	BDL	BDL	BDL	557.2	583.3	BDL
UA-12a	Animas above Eureka Gulch 1020	549.1	BDL	85780.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	568.2	614.7	BDL
UA-12b	Animas above Eureka Gulch	910.5	BDL	83397.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	538.4	604.4	BDL
UA-12c	Animas above Eureka Gulch	637.8	BDL	88920.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	548.7	597.3	BDL
UA-12d	Animas above Eureka Gulch	653.3	BDL	92620.1	14168.7	BDL	BDL	BDL	BDL	BDL	BDL	587.1	612.0	BDL
UA-12e	Animas above Eureka Gulch	431.7	BDL	122642.1	15180.2	BDL	BDL	BDL	BDL	BDL	BDL	591.8	631.8	BDL
UA-12f	Animas above Eureka Gulch	1162.0	BDL	125386.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	661.0	684.7	BDL
CG-1	California Gulch Above Mtn. Queen	1.3	BDL	66.7	36.0	BDL	BDL	BDL	BDL	BDL	BDL	0.4	0.4	BDL
CG-2	California Gulch below Mtn. Queen	18.5	6.6	38179.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	25.4	19.7	BDL
CG-3	Cal Gulch above DM-11-16	54.5	BDL	145560.7	69527.6	BDL	BDL	BDL	BDL	BDL	BDL	163.0	156.1	BDL
CG-13	Duplicate of CG-4 metals & CG-3 Anions	BDL	BDL	BDL	0.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0	BDL
CG-4	Cal Gulch below DM-11-16	55.3	BDL	182248.2	72682.3	BDL	BDL	BDL	BDL	BDL	BDL	191.5	183.3	BDL
CG-5	Tributary below DM-17	3.3	BDL	1004.4	1090.3	BDL	BDL	BDL	BDL	BDL	BDL	18.4	17.1	BDL
CG-6	Cal Gulch below DM-17 tributary	94.5	27.5	148931.9	73568.7	BDL	BDL	BDL	BDL	BDL	BDL	232.1	220.1	BDL
CG-7	Cal Gulch above Placer Gulch	117.5	BDL	191304.2	73145.7	BDL	BDL	BDL	BDL	BDL	BDL	210.7	208.8	BDL
CG-8	Cal Gulch below Placer Gulch	84.8	BDL	209074.2	42474.1	BDL	BDL	BDL	BDL	BDL	BDL	279.7	263.7	BDL
CG-9	Cal Gulch below Bagley Mine Drainage	307.2	BDL	172028.1	48033.8	BDL	BDL	BDL	BDL	BDL	BDL	320.6	306.1	BDL
CG-10	Cal Gulch below Bagley Mill Tailings	BDL	BDL	124683.4	37724.7	BDL	BDL	BDL	BDL	BDL	BDL	290.9	288.8	BDL
CG-11	Cal Gulch above Columbus Mine	248.6	BDL	155084.1	42167.5	BDL	BDL	BDL	BDL	BDL	BDL	351.2	347.3	BDL
CG-12a	Cal Gulch at Mouth	268.2	BDL	82522.2	34448.5	BDL	BDL	BDL	BDL	BDL	BDL	265.6	300.8	BDL
CG-12b	Cal Gulch at Mouth	226.4	35.4	89923.2	37087.5	BDL	BDL	BDL	BDL	BDL	BDL	287.0	290.7	BDL
CG-12c	Cal Gulch at Mouth	85.1	37.6	87330.4	35111.3	BDL	BDL	BDL	BDL	BDL	BDL	284.8	278.6	BDL
CG-12d	Cal Gulch at Mouth	BDL	BDL	103255.9	39297.4	BDL	BDL	BDL	BDL	BDL	BDL	304.8	322.8	BDL
CG-12e	Cal Gulch at Mouth	99.2	BDL	130511.2	39675.4	BDL	BDL	BDL	BDL	BDL	BDL	312.2	310.1	BDL
CG-12f	Cal Gulch at Mouth	184.1	BDL	222174.8	41611.7	BDL	BDL	BDL	BDL	BDL	BDL	351.1	352.3	BDL
BG-2	Burrows Creek above London Mine	9.2	BDL	10921.2	12603.2	BDL	BDL	BDL	BDL	BDL	BDL	44.7	44.2	BDL
BG-3	Burrows Creek below London Mine	53.7	BDL	20197.8	25939.0	BDL	BDL	BDL	BDL	BDL	BDL	81.6	85.1	BDL

Upper Animas High-Flow
Loading Data

Site #	Description	Tot. Ag	Diss. Ag	Tot. Al	Diss. Al	Tot. As	Diss. As	Tot. Ba	Diss. Ba	Tot. Be	Diss. Be	Tot. Cd	Diss. Cd	Tot. Co
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
BG-7	Duplicate of BG-3, metals & BG-4 anions	7.7	BDL	22134.6	25178.1	BDL	BDL	BDL	BDL	BDL	BDL	83.0	95.3	BDL
BG-4	Burrows Creek above Large Fault	20.4	BDL	23442.3	27086.7	BDL	BDL	BDL	BDL	BDL	BDL	96.0	86.8	BDL
BG-5	Burrows Creek above Animas	BDL	BDL	23422.1	24983.6	BDL	BDL	BDL	BDL	BDL	BDL	86.0	89.2	BDL
LJ-1	Animas below Lucky Jack Mine	BDL	BDL	192.9	126.6	BDL	BDL	BDL	BDL	BDL	BDL	6.9	6.7	BDL
HC-1	Horseshoe Creek	19.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7.0	BDL	BDL
PL-1	Placer Gulch	314.5	BDL	23474.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	128.8	129.9	BDL
CN-1	Cinnamon Creek	197.3	BDL	81462.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GG-1	Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
PY-1	Picayune Gulch	94.1	BDL	4641.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BU-1	Burns Gulch	113.9	BDL	2527.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	221.3	206.7	BDL
NG-1	Niagra Gulch	14.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-1	Unknown Prospect Above Denver Lake	0.0	0.0	5.3	2.3	BDL	BDL	BDL	BDL	BDL	BDL	0.2	0.2	BDL
DM-2	Lucky Jack Mine Drainage	19.9	0.0	16.5	15.0	BDL	BDL	BDL	BDL	BDL	BDL	0.3	0.4	BDL
DM-4	Early Bird Mine Drainage	0.1	0.0	414.1	445.7	BDL	BDL	BDL	BDL	BDL	BDL	1.4	1.5	BDL
DM-5	Draining Mine near London Mine-West	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.2	0.2	BDL
DM-6	Draining Mine near London Mine-East	0.1	BDL	1.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.1	0.2	BDL
DM-7	London Mine Drainage	0.0	BDL	6.7	BDL	0.1	BDL	BDL	BDL	BDL	BDL	0.3	0.3	BDL
DM-8	Prairie Mine Drainage	0.0	BDL	9.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0	0.0	BDL
DM-10	Mountain Queen Adit Drainage	BDL	0.0	106.6	110.3	BDL	BDL	BDL	BDL	BDL	BDL	1.2	1.2	BDL
DM-11	Little Ida Mine Drainage - Upper Adit	BDL	BDL	5.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.3	0.3	BDL
DM-13	Little Ida Mine Drainage - Middle Adit	0.0	BDL	6.9	0.7	BDL	BDL	BDL	BDL	BDL	BDL	0.1	0.0	BDL
DM-14	Little Ida Mine Drainage - Lower Adit	BDL	0.0	1.3	7.4	BDL	BDL	BDL	BDL	BDL	BDL	0.0	0.1	BDL
DM-15	Burrows Mine Drainage - West	BDL	BDL	5.6	5.6	BDL	BDL	BDL	BDL	BDL	BDL	0.2	0.3	BDL
DM-16	Burrows Mine Drainage - East	0.0	BDL	14.2	1.3	BDL	BDL	BDL	BDL	BDL	BDL	0.4	0.4	BDL
DM-17	Vermillion Mine Drainage	1.5	0.3	163.9	159.5	BDL	BDL	BDL	BDL	BDL	BDL	0.2	18.2	BDL
DM-18	Vermillion Tunnel Mine Drainage	BDL	BDL	20.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.9	0.8	BDL
DM-19	Bagley Tunnel Drainage	BDL	BDL	61.9	26.2	BDL	BDL	BDL	BDL	BDL	BDL	2.1	2.1	BDL
DM-31	Duplicate of DM-19	BDL	BDL	26.1	27.7	BDL	BDL	BDL	BDL	BDL	BDL	2.4	2.2	BDL
DM-20	Columbus Mine Drainage	13.5	0.0	255.1	276.4	0.4	BDL	BDL	BDL	BDL	BDL	17.3	2.5	2.8
DM-21	Silver Wing Mine Drainage	0.0	BDL	40.6	8.2	1.1	BDL	BDL	BDL	BDL	BDL	0.6	0.6	BDL
DM-22	Tom Moore Mine Drainage	BDL	BDL	14.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.6	0.5	BDL
DM-24	Senator Mine Drainage	BDL	BDL	240.6	132.7	BDL	BDL	BDL	BDL	BDL	BDL	0.3	BDL	BDL
DM-25	Silver Queen Mine Drainage	12.9	0.0	14.4	12.6	0.4	BDL	BDL	BDL	BDL	BDL	0.2	0.2	BDL
DM-26	Sound Democrat Mine Drainage	224.1	BDL	1317.6	149.9	BDL	BDL	BDL	BDL	BDL	BDL	1.4	1.5	BDL
DM-27	Golden Fleece Mine Drainage	25.3	0.0	117.2	127.0	BDL	BDL	BDL	BDL	0.0	BDL	0.2	0.2	BDL
DM-28	Indian Chief Mine Drainage	0.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.1	BDL	BDL
DM-29	Toltec Mine Drainage	BDL	BDL	6.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0	BDL	BDL
DM-32	Duplicate of DM29	BDL	BDL	16.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.1	BDL	BDL
DM-30	Unknown Draining Mine South of Grouse	0.0	BDL	1.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Upper Animas High-Flow
Loading Data

Site #	Description	Diss. Co	Tot. Cr	Diss. Cr	Tot. Cu	Diss. Cu	Tot. Fe	Diss. Fe	Tot. Mn	Diss. Mn	Tot. Ni
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
UA-1	Animas above Denver Lake	BDL	BDL	BDL	12.7	BDL	573.7	126.3	59.2	41.2	BDL
UA-2	Animas above Lucky Jack Mine	BDL	12.7	BDL	BDL	BDL	42.2	BDL	BDL	BDL	BDL
UA-3	Animas above Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	1035.0	255.3	119.3	58.2	BDL
UA-4	Animas below Burrows Creek	BDL	BDL	BDL	356.8	198.3	3753.8	659.6	19862.1	18914.5	BDL
UA-5	Animas below mining complex	BDL	BDL	BDL	497.9	BDL	4112.8	458.9	19568.3	18962.2	BDL
UA-6a	Animas above Cal Gulch	BDL	BDL	BDL	335.1	230.3	3483.7	BDL	20284.6	20872.6	BDL
UA-6b	Animas above Cal Gulch	BDL	BDL	BDL	348.7	BDL	3413.4	BDL	15374.4	17331.9	BDL
UA-6c	Animas above Cal Gulch	BDL	BDL	BDL	347.1	BDL	3888.8	BDL	16140.8	17437.0	BDL
UA-6d	Animas above Cal Gulch	BDL	BDL	BDL	280.4	253.8	3904.1	BDL	18531.1	19930.6	BDL
UA-6e	Animas above Cal Gulch	BDL	BDL	BDL	363.5	237.5	4853.5	BDL	18527.3	19133.9	BDL
UA-6f	Animas above Cal Gulch	BDL	BDL	BDL	334.7	BDL	3479.1	587.2	20258.3	19964.7	BDL
UA-7	Animas below California Gulch	BDL	BDL	BDL	2922.7	1211.1	57808.5	1937.7	303575.5	300346.0	BDL
UA-11	Animas above Niagra Gulch	BDL	BDL	BDL	2655.9	BDL	25647.5	BDL	233041.1	224708.9	BDL
UA-12a	Animas above Eureka Gulch 1020	BDL	BDL	BDL	2488.7	1267.6	18057.5	BDL	225104.3	228928.9	BDL
UA-12b	Animas above Eureka Gulch	BDL	BDL	BDL	2589.0	BDL	18130.9	BDL	220896.7	220632.7	BDL
UA-12c	Animas above Eureka Gulch	BDL	BDL	BDL	2864.9	1256.8	23973.3	BDL	222165.4	228381.7	BDL
UA-12d	Animas above Eureka Gulch	BDL	BDL	BDL	3142.5	BDL	21446.0	BDL	239544.4	231826.0	BDL
UA-12e	Animas above Eureka Gulch	BDL	BDL	BDL	2944.6	1526.6	47455.9	BDL	246141.9	253288.9	BDL
UA-12f	Animas above Eureka Gulch	BDL	BDL	BDL	3557.1	1526.6	27389.3	BDL	267964.6	269150.3	BDL
CG-1	California Gulch Above Mtn. Queen	BDL	BDL	BDL	3.5	3.0	54.6	BDL	56.0	55.0	BDL
CG-2	California Gulch below Mtn. Queen	BDL	BDL	BDL	836.7	93.9	51514.6	BDL	7124.4	2648.8	BDL
CG-3	Cal Gulch above DM-11-16	BDL	BDL	BDL	1268.6	548.9	87824.3	BDL	202890.4	200450.9	BDL
CG-13	Duplicate of CG-4 metals & CG-3 Anions	BDL	BDL	BDL	BDL	0.0	0.0	BDL	0.0	0.0	BDL
CG-4	Cal Gulch below DM-11-16	BDL	BDL	BDL	1524.2	623.8	120414.0	737.7	226725.4	228352.6	BDL
CG-5	Tributary below DM-17	BDL	BDL	BDL	134.0	138.6	339.5	253.6	960.5	960.5	BDL
CG-6	Cal Gulch below DM-17 tributary	BDL	BDL	BDL	1650.8	807.5	70578.1	1441.5	241640.4	232070.5	BDL
CG-7	Cal Gulch above Placer Gulch	BDL	BDL	BDL	1500.4	756.5	114407.4	1437.9	234441.4	240693.2	BDL
CG-8	Cal Gulch below Placer Gulch	BDL	BDL	BDL	2665.2	1186.6	150684.1	1780.0	256163.0	242978.2	BDL
CG-9	Cal Gulch below Bagley Mine Drainage	BDL	BDL	BDL	2736.8	1407.5	89588.6	3552.3	288202.9	282617.5	BDL
CG-10	Cal Gulch below Bagley Mill Tailings	BDL	BDL	BDL	2440.4	1246.8	46996.1	1673.1	254695.2	255760.9	BDL
CG-11	Cal Gulch above Columbus Mine	BDL	BDL	BDL	2947.9	1358.6	63059.0	1653.4	306323.1	301196.3	BDL
CG-12a	Cal Gulch at Mouth	BDL	BDL	BDL	1525.3	1294.0	10368.8	2142.3	224515.2	237369.1	BDL
CG-12b	Cal Gulch at Mouth	BDL	BDL	BDL	1742.6	1397.8	15095.9	2078.0	232961.7	257189.7	BDL
CG-12c	Cal Gulch at Mouth	BDL	BDL	BDL	1710.8	1316.7	12539.7	2006.4	239150.8	251690.5	BDL
CG-12d	Cal Gulch at Mouth	BDL	BDL	BDL	2095.2	1423.5	17343.0	2325.8	255633.6	275683.3	BDL
CG-12e	Cal Gulch at Mouth	BDL	BDL	BDL	2276.1	1409.5	42807.7	1775.0	256846.1	275639.7	BDL
CG-12f	Cal Gulch at Mouth	BDL	BDL	BDL	3301.9	1509.8	138705.8	1988.5	277411.6	305643.8	BDL
BG-2	Burrows Creek above London Mine	BDL	BDL	BDL	61.3	62.4	334.1	294.9	5322.4	5575.8	BDL
BG-3	Burrows Creek below London Mine	BDL	BDL	BDL	269.8	316.8	947.6	712.5	14802.5	17085.1	BDL

Upper Animas High-Flow
Loading Data

Site #	Description	Diss. Co	Tot. Cr	Diss. Cr	Tot. Cu	Diss. Cu	Tot. Fe	Diss. Fe	Tot. Mn	Diss. Mn	Tot. Ni
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
BG-7	Duplicate of BG-3, metals & BG-4 anions	BDL	BDL	BDL	287.7	292.6	747.0	655.7	15978.4	17016.0	BDL
BG-4	Burrows Creek above Large Fault	BDL	BDL	BDL	329.0	330.0	1103.2	786.0	16350.5	17434.0	BDL
BG-5	Burrows Creek above Animas	BDL	BDL	BDL	301.6	311.3	835.4	605.1	16200.3	16102.7	BDL
LJ-1	Animas below Lucky Jack Mine	BDL	BDL	BDL	8.5	BDL	319.5	88.3	161.9	171.7	BDL
HC-1	Horseshoe Creek	BDL	BDL	BDL	52.1	BDL	1493.3	BDL	68.0	BDL	254.4
PL-1	Placer Gulch	BDL	BDL	BDL	1823.2	752.1	8204.6	1589.6	73499.3	82045.7	BDL
CN-1	Cinnamon Creek	BDL	BDL	BDL	265.3	BDL	97754.4	791.3	7331.6	243.8	BDL
GG-1	Grouse Gulch	BDL	BDL	BDL	BDL	BDL	3500.8	#VALUE!	419.8	BDL	BDL
PY-1	Picayune Gulch	BDL	BDL	BDL	BDL	BDL	4185.8	489.0	2325.0	1558.3	BDL
BU-1	Burns Gulch	BDL	BDL	BDL	855.1	778.4	1691.1	BDL	4179.7	4141.4	BDL
NG-1	Niagra Gulch	BDL	BDL	BDL	BDL	BDL	226.5	BDL	BDL	BDL	BDL
DM-1	Unknown Prospect Above Denver Lake	BDL	BDL	BDL	0.4	0.3	40.9	20.0	1.1	1.1	0.2
DM-2	Lucky Jack Mine Drainage	BDL	BDL	BDL	1.0	1.0	31.2	23.8	6.0	7.1	BDL
DM-4	Early Bird Mine Drainage	BDL	BDL	BDL	31.5	33.0	166.3	173.8	178.8	189.6	BDL
DM-5	Draining Mine near London Mine-West	BDL	BDL	BDL	1.3	1.0	12.3	6.3	0.3	0.3	BDL
DM-6	Draining Mine near London Mine-East	BDL	BDL	BDL	0.5	0.6	7.6	4.6	2.0	2.0	BDL
DM-7	London Mine Drainage	BDL	BDL	BDL	1.4	0.1	54.0	2.4	9.2	7.3	BDL
DM-8	Prairie Mine Drainage	BDL	BDL	BDL	0.1	BDL	4.3	BDL	1.3	0.1	BDL
DM-10	Mountain Queen Adit Drainage	BDL	BDL	BDL	41.5	42.9	189.2	159.0	91.8	96.2	BDL
DM-11	Little Ida Mine Drainage - Upper Adit	BDL	BDL	BDL	1.1	0.9	15.0	7.8	0.8	0.7	BDL
DM-13	Little Ida Mine Drainage - Middle Adit	BDL	BDL	BDL	1.3	0.2	1.7	BDL	2.3	0.6	BDL
DM-14	Little Ida Mine Drainage - Lower Adit	BDL	BDL	BDL	0.2	1.6	0.3	0.4	0.7	3.0	BDL
DM-15	Burrows Mine Drainage - West	BDL	BDL	BDL	0.9	0.8	0.6	0.1	4.8	5.1	BDL
DM-16	Burrows Mine Drainage - East	BDL	BDL	BDL	0.5	0.3	0.9	0.6	6.7	6.9	BDL
DM-17	Vermillion Mine Drainage	BDL	BDL	BDL	75.2	81.1	850.5	924.3	521.1	565.4	BDL
DM-18	Vermillion Tunnel Mine Drainage	BDL	BDL	BDL	1.4	BDL	121.8	BDL	235.6	238.2	BDL
DM-19	Bagley Tunnel Drainage	BDL	BDL	BDL	1.4	BDL	172.8	42.8	1969.1	2062.7	BDL
DM-31	Duplicate of DM-19	BDL	BDL	BDL	BDL	BDL	165.7	40.9	2057.0	2040.0	BDL
DM-20	Columbus Mine Drainage	3.3	BDL	BDL	134.9	145.7	1055.8	1147.0	166.1	179.1	1.2
DM-21	Silver Wing Mine Drainage	BDL	BDL	BDL	85.3	9.1	554.7	214.7	171.6	179.8	BDL
DM-22	Tom Moore Mine Drainage	BDL	BDL	BDL	1.0	BDL	32.4	BDL	166.5	149.5	BDL
DM-24	Senator Mine Drainage	BDL	BDL	BDL	BDL	BDL	9577.0	9577.0	3377.6	3368.3	18.1
DM-25	Silver Queen Mine Drainage	BDL	BDL	BDL	22.6	22.6	325.0	162.3	256.1	256.1	BDL
DM-26	Sound Democrat Mine Drainage	BDL	BDL	BDL	42.1	31.6	2069.8	17.0	2044.6	2009.3	BDL
DM-27	Golden Fleece Mine Drainage	BDL	BDL	BDL	2.1	2.3	206.9	219.3	249.9	263.9	BDL
DM-28	Indian Chief Mine Drainage	BDL	BDL	BDL	BDL	BDL	15.8	2.2	22.5	13.7	BDL
DM-29	Toltec Mine Drainage	BDL	BDL	BDL	1.6	0.2	32.8	1.7	15.3	1.4	BDL
DM-32	Duplicate of DM29	BDL	BDL	BDL	3.5	BDL	49.2	BDL	36.3	0.9	BDL
DM-30	Unknown Draining Mine South of Grouse	BDL	BDL	BDL	0.1	BDL	1.5	BDL	0.8	0.7	BDL

Upper Animas High-Flow
Loading Data

Site #	Description	Diss. Ni	Tot. Pb	Diss. Pb	Tot. Sb	Diss. Sb	Tot. Se	Diss. Se	Tot. Th	Diss. Th	Tot. Va	Diss. Va	Tot.Zn	Diss. Zn
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
UA-1	Animas above Denver Lake	BDL	12.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-2	Animas above Lucky Jack Mine	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	18.2	BDL
UA-3	Animas above Horseshoe Creek	BDL	26.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
UA-4	Animas below Burrows Creek	BDL	258.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12354.6	11261.3
UA-5	Animas below mining complex	BDL	302.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13117.7	12035.4
UA-6a	Animas above Cal Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13670.1	15678.9
UA-6b	Animas above Cal Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10399.1	13335.3
UA-6c	Animas above Cal Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10913.8	13715.5
UA-6d	Animas above Cal Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	12981.4	15828.6
UA-6e	Animas above Cal Gulch	BDL	352.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13487.1	15027.1
UA-6f	Animas above Cal Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13652.3	15756.5
UA-7	Animas below California Gulch	BDL	2050.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	87035.7	81222.6
UA-11	Animas above Niagra Gulch	BDL	2142.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	78374.7	76812.4
UA-12a	Animas above Eureka Gulch 1020	BDL	1518.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	83321.4	72394.0
UA-12b	Animas above Eureka Gulch	BDL	1483.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	80494.0	67826.1
UA-12c	Animas above Eureka Gulch	BDL	1718.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	75947.0	69190.2
UA-12d	Animas above Eureka Gulch	BDL	1598.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	79940.0	65881.6
UA-12e	Animas above Eureka Gulch	BDL	1875.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	78902.6	87479.0
UA-12f	Animas above Eureka Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	98411.8	95151.2
CG-1	California Gulch Above Mtn. Queen	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	56.0	40.3
CG-2	California Gulch below Mtn. Queen	BDL	798.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3489.1	2100.8
CG-3	Cal Gulch above DM-11-16	BDL	870.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	34072.6	32649.5
CG-13	Duplicate of CG-4 metals & CG-3 Anions	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0	0.0
CG-4	Cal Gulch below DM-11-16	BDL	1204.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	39649.8	38727.7
CG-5	Tributary below DM-17	BDL	110.8	108.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3354.7	3274.8
CG-6	Cal Gulch below DM-17 tributary	BDL	1166.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	46174.9	45875.8
CG-7	Cal Gulch above Placer Gulch	BDL	1250.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	42387.0	63768.1
CG-8	Cal Gulch below Placer Gulch	BDL	2420.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	61498.0	59331.9
CG-9	Cal Gulch below Bagley Mine Drainage	BDL	1966.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	70375.1	40549.5
CG-10	Cal Gulch below Bagley Mill Tailings	BDL	1960.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	65538.7	66284.7
CG-11	Cal Gulch above Columbus Mine	BDL	2268.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	80105.4	76773.0
CG-12a	Cal Gulch at Mouth	BDL	537.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	63669.8	64869.5
CG-12b	Cal Gulch at Mouth	BDL	855.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	65415.6	69702.1
CG-12c	Cal Gulch at Mouth	BDL	656.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	64848.4	67266.8
CG-12d	Cal Gulch at Mouth	BDL	861.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	69171.4	76088.6
CG-12e	Cal Gulch at Mouth	BDL	1158.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	69014.3	73295.1
CG-12f	Cal Gulch at Mouth	BDL	2675.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	74631.1	84696.5
BG-2	Burrows Creek above London Mine	BDL	43.5	26.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7580.3	7833.8
BG-3	Burrows Creek below London Mine	BDL	39.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9753.1	11067.3

Upper Animas High-Flow
Loading Data

Site #	Description	Diss. Ni	Tot. Pb	Diss. Pb	Tot. Sb	Diss. Sb	Tot. Se	Diss. Se	Tot. Th	Diss. Th	Tot. Va	Diss. Va	Tot.Zn	Diss. Zn
		g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day
BG-7	Duplicate of BG-3, metals & BG-4 anions	BDL	34.9	120.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10721.4	11344.0
BG-4	Burrows Creek above Large Fault	BDL	129.0	116.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11031.7	11622.7
BG-5	Burrows Creek above Animas	BDL	198.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11320.7	10832.7
LJ-1	Animas below Lucky Jack Mine	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	637.7	591.2
HC-1	Horseshoe Creek	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	755.5	BDL
PL-1	Placer Gulch	BDL	866.0	BDL	3093.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	31792.7	33559.0
CN-1	Cinnamon Creek	BDL	395.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
GG-1	Grouse Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
PY-1	Picayune Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	#VALUE!	480.7
BU-1	Burns Gulch	BDL	582.9	365.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	22854.4	23199.5
NG-1	Niagra Gulch	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
DM-1	Unknown Prospect Above Denver Lake	BDL	4.6	3.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	20.4	21.9
DM-2	Lucky Jack Mine Drainage	BDL	4.3	3.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	51.4	61.1
DM-4	Early Bird Mine Drainage	BDL	2.3	2.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	109.8	112.3
DM-5	Draining Mine near London Mine-West	BDL	2.1	1.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	23.8	23.8
DM-6	Draining Mine near London Mine-East	BDL	2.3	1.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	23.8	24.7
DM-7	London Mine Drainage	BDL	0.5	BDL	BDL	BDL	0.0	BDL	BDL	BDL	BDL	BDL	47.8	46.4
DM-8	Prairie Mine Drainage	BDL	0.4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8.5	6.6
DM-10	Mountain Queen Adit Drainage	BDL	4.2	3.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	122.0	122.7
DM-11	Little Ida Mine Drainage - Upper Adit	BDL	5.0	24.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	40.1	36.0
DM-13	Little Ida Mine Drainage - Middle Adit	BDL	2.0	1.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	19.0	3.1
DM-14	Little Ida Mine Drainage - Lower Adit	BDL	1.7	2.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.4	24.3
DM-15	Burrows Mine Drainage - West	BDL	7.5	9.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	44.1	47.3
DM-16	Burrows Mine Drainage - East	BDL	0.2	0.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	97.1	103.8
DM-17	Vermillion Mine Drainage	BDL	416.2	485.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3703.6	4096.9
DM-18	Vermillion Tunnel Mine Drainage	BDL	2.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	248.7	233.4
DM-19	Bagley Tunnel Drainage	BDL	2.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1047.0	1151.9
DM-31	Duplicate of DM-19	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1132.1	1134.9
DM-20	Columbus Mine Drainage	0.7	16.4	23.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3482.5	3924.7
DM-21	Silver Wing Mine Drainage	BDL	1.5	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	163.9	166.9
DM-22	Tom Moore Mine Drainage	BDL	1.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	173.9	160.6
DM-24	Senator Mine Drainage	BDL	3.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	214.0	188.3
DM-25	Silver Queen Mine Drainage	BDL	5.2	1.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	61.1	59.8
DM-26	Sound Democrat Mine Drainage	BDL	26.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	405.9	367.5
DM-27	Golden Fleece Mine Drainage	BDL	1.4	1.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	25.5	26.3
DM-28	Indian Chief Mine Drainage	BDL	3.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9.5	5.3
DM-29	Toltec Mine Drainage	BDL	0.8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.0	5.2
DM-32	Duplicate of DM29	BDL	1.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	17.6	BDL
DM-30	Unknown Draining Mine South of Grouse	BDL	0.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.7	0.7

APPENDIX 3

Upper Animas
Mining Waste Analyses

Sample #	Description	pH	Total Acidity	Conductivity	Ag	Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe
		s.u.	mg/l	uS/cm	ppb	ppb	ppb	ppb	ppb	ppb	ppm	ppb	ppb	ppb	ppb	ppb
1	Mountain Queen Shaft	3.73	57	111	7	220	BDL	BDL	78	BDL	2.2	20	BDL	BDL	280	2300
2	Mountain Queen Adit	3.63	144	108	1	280	BDL	BDL	60	BDL	1.9	28	BDL	BDL	390	230
3	Little Chief Mine	5.13	2	173	51	210	BDL	BDL	27	BDL	6	49	BDL	BDL	46	63
4 & 5 Composite	Little Ida Mine	3.64	55	191	BDL	1800	BDL	BDL	50	1	2.3	26	12	BDL	620	1500
6	Vermillion Mine	3.99	1207	741	BDL	2300	BDL	BDL	44	BDL	5.8	84	10	BDL	590	7200
7	*Burrows Mine - West Adit*	*3.09*	*55*	*508*	*2*	*610*	*BDL*	*BDL*	*33*	*BDL*	*8.6*	*22*	*5*	*BDL*	*300*	*1200*
8	Burrows Mine - East Adit	3.23	48	356	1	280	BDL	BDL	36	BDL	3.4	33	BDL	BDL	180	590
9	Vermillion Tunnel	4.17	28.5	78	BDL	40	BDL	BDL	30	BDL	2.6	4	BDL	BDL	19	73
10	Bagley Tunnel	4.3	ND	99	BDL	76	BDL	BDL	49	BDL	4.5	8	BDL	BDL	38	81
11	Bagley Mill Tailings	4.01	15	101	1	130	BDL	BDL	75	BDL	1.8	9	BDL	BDL	180	160
12	Mine in Cal Gulch Above Animas Forks	6.25	77.6	543	2	2600	BDL	BDL	41	1	3.2	110	15	BDL	1200	210
13	Columbus Adit	4.2	350	258	BDL	440	BDL	BDL	80	1	18	54	BDL	BDL	660	190
14	Silver Queen Mine	4.14	29.8	91	5	570	BDL	BDL	53	3	77	28	BDL	BDL	320	110
15	Lucky Jack Mine	2.86	1,298	1180	3	3300	BDL	BDL	46	3	28	130	48	BDL	610	2900
16	Unknown Prospect North of Denver Lake	4.04	78	101	1	35	BDL	BDL	36	BDL	1.4	1	BDL	BDL	4	120
17	Unknown Prospect in Burrows Creek	4.64	22	29	1	70	BDL	BDL	26	BDL	1.4	BDL	BDL	BDL	2	260
17 FILTERED	Unknown Prospect in Burrows Creek	4.64	22	29	2	190	BDL	38	21	BDL	0.38	BDL	BDL	BDL	2	380
18	London Mine	3.34	30	294	1	230	BDL	BDL	65	BDL	2	10	BDL	BDL	140	830
19	Paris Mine	3.24	49	448	3	1400	BDL	BDL	20	BDL	18	3	5	BDL	220	1000
20	Ben Butler Mine	2.63	552	2220	BDL	12000	BDL	61	29	1	6.2	350	65	BDL	3500	97000
21	Boston Mine	3.65	26	123	1	88	BDL	BDL	50	BDL	1.3	4	BDL	BDL	32	230
22	Red Cloud Mine	3.27	49	363	BDL	440	BDL	BDL	150	BDL	3.5	41	BDL	BDL	170	1100
23	Eagle Chief Mine	3.59	861	555	2	1100	BDL	BDL	41	3	8.9	210	26	BDL	3200	91
24	Riverside Mine	4.3	58	81	BDL	69	BDL	BDL	35	BDL	3.2	2	BDL	BDL	37	310
25	North Composite-Columbus Group	3.63	0.3	217	2	230	BDL	BDL	54	BDL	2.8	27	BDL	BDL	380	210
Duplicate Extract 25	North Composite-Columbus Group	3.19	3.8	244												
26	Southwest Composite-Columbus Group	4.18	160	110	1	85	BDL	BDL	59	BDL	1.9	28	BDL	BDL	240	160
27	Southeast Composite-Columbus Group	2.53	314	232	BDL	280	BDL	BDL	130	BDL	3.5	13	BDL	BDL	260	310
27A	Composite Along Stream-Columbus Group	4.17	113	106	BDL	300	BDL	BDL	140	BDL	3.7	27	BDL	BDL	530	560
28	Mill Tailings above Grouse Gulch	5.43	256	313	13	96	BDL	BDL	15	BDL	8.5	87	BDL	BDL	350	74
29	Unknown Mine South of Grouse Gulch	5.44	42	101	1	130	BDL	BDL	27	BDL	5	1	BDL	BDL	8	140
30	Toltec Mine	6.52	44	595	2	30	BDL	BDL	36	BDL	78	11	BDL	BDL	3	91
31	Unknown Mine near Picayune Gulch	4.02	98	106	2	100	BDL	BDL	63	BDL	3.3	2	BDL	BDL	16	52
32	Silver Wing Mine	2.62	3,534	1960	BDL	12000	BDL	BDL	64	BDL	33	120	44	BDL	15000	48000
33	Tom Moore Mine	2.94	2,382	2420	9	12000	BDL	BDL	29	4	238	270	27	BDL	760	6000
34	Sioux City Mine	2.85	1,136	1040	4	410	BDL	BDL	42	BDL	2.9	63	BDL	BDL	940	1400
36	Silver Bell Mine	2.9	893	853	1	400	BDL	BDL	44	BDL	2	3	BDL	BDL	1200	4700
37	Protection Mine	5.39	412	692	3	2200	BDL	BDL	82	3	62	63	5	BDL	130	90
38	Senator Mine	3.46	247	355	BDL	1200	BDL	BDL	54	BDL	11	4	BDL	BDL	140	120
39	Treasure Mountain Mine	7.49	201	36	5	1300	BDL	BDL	40	BDL	16	2	BDL	BDL	14	2200
40	Golden Fleece Mine	2.88	101.4	1150	2	2600	BDL	BDL	24	3	37	5	21	BDL	87	4500
41	Unknown Prospect in Picayune Gulch	4.52	52	87	1	35	BDL	BDL	41	BDL	5.7	BDL	BDL	BDL	5	55
42	Sound Democrat Mine	3.8	103	135	BDL	110	BDL	BDL	36	BDL	2.6	2	BDL	BDL	30	75
43	Mine West of Columbus Group	3.91	105	110	4	79	BDL	BDL	40	BDL	1.2	4	BDL	BDL	62	130
Picayune Soil	Vegetated Soil	6.17	43	80	BDL	140	BDL	BDL	29	BDL	2.7	BDL	BDL	BDL	3	180
Burrows Gulch Soil	Vegetated Soil	5.55	60	128	5	230	BDL	BDL	35	BDL	2.7	BDL	BDL	BDL	3	270
Burns Gulch Talus	Mixed Talus and Mine Waste	5.29	39	61	BDL	36	BDL	BDL	34	BDL	2.2	3	BDL	BDL	17	80

Sample #	Description	K	Li	Mg	Mn	Mo	Na	Ni	P	Pb	S	Sb	Se	Si	Sn	Sr	Ti	V	Zn
		ppm	ppb	ppm	ppb	ppb	ppm	ppb	ppb	ppb	ppm	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
1	Mountain Queen Shaft	0.38	BDL	0.53	64	BDL	1.1	5	BDL	6500	18	BDL	BDL	380	BDL	BDL	BDL	BDL	3300
2	Mountain Queen Adit	0.78	3	0.49	460	BDL	0.43	BDL	BDL	2000	13	BDL	BDL	1400	BDL	BDL	BDL	BDL	5100
3	Little Chief Mine	5	BDL	1.2	6900	BDL	1.5	BDL	BDL	BDL	16	BDL	BDL	920	BDL	BDL	BDL	BDL	6400
4 & 5 Composite	Little Ida Mine	0.87	2	0.59	1400	BDL	0.68	7	36	12000	16	BDL	BDL	950	BDL	BDL	BDL	BDL	6100
6	Vermillion Mine	0.51	BDL	0.93	1400	BDL	0.95	11	BDL	2500	47	BDL	BDL	1000	BDL	BDL	BDL	BDL	18000
7	Burrows Mine - West Adit	0.25	BDL	1.6	1700	BDL	0.8	7	80	1500	26	BDL	BDL	1100	BDL	BDL	BDL	BDL	5100
8	Burrows Mine - East Adit	0.25	BDL	0.9	400	BDL	1.1	BDL	BDL	5000	17	BDL	BDL	590	BDL	BDL	BDL	BDL	7600
9	Vermillion Tunnel	0.72	BDL	0.44	290	BDL	0.9	BDL	BDL	16	4.3	BDL	BDL	800	BDL	BDL	BDL	BDL	1000
10	Bagley Tunnel	1	2	0.53	1000	BDL	0.95	BDL	BDL	380	7.7	BDL	BDL	1400	BDL	BDL	BDL	BDL	2100
11	Bagley Mill Tailings	0.52	BDL	0.48	190	BDL	0.9	BDL	BDL	13000	6.5	BDL	BDL	1200	BDL	BDL	BDL	BDL	1800
12	Mine in Cal Gulch Above Animas Forks	0.75	4	2.5	9900	BDL	0.73	11	BDL	3700	39	BDL	BDL	2600	BDL	BDL	BDL	17.7	21000
13	Columbus Adit	2.3	7	2.2	1.8	BDL	0.94	6	BDL	1000	29	BDL	BDL	2200	BDL	BDL	BDL	BDL	10000
14	Silver Queen Mine	1	4	2.5	34000	BDL	0.89	10	BDL	93	98	BDL	BDL	2300	BDL	BDL	BDL	BDL	10000
15	Lucky Jack Mine	1.2	6	2.4	6800	BDL	1.1	14	BDL	4400	77	BDL	BDL	2300	BDL	140	BDL	BDL	20000
16	Unknown Prospect North of Denver Lake	1.6	BDL	0.37	9	BDL	0.95	BDL	BDL	57	3.6	BDL	BDL	960	BDL	BDL	BDL	BDL	150
17	Unknown Prospect in Burrows Creek	0.58	BDL	0.36	12	8	1	BDL	BDL	57	1.9	BDL	BDL	630	BDL	BDL	BDL	BDL	69
17 FILTERED	Unknown Prospect in Burrows Creek	0.68	BDL	0.087	10	7	0.46	14	28	66	1	BDL	BDL	870	BDL	BDL	BDL	BDL	74
18	London Mine	0.49	BDL	0.39	270	BDL	0.7	BDL	BDL	4000	11	BDL	BDL	740	BDL	BDL	BDL	BDL	1700
19	Paris Mine	1.1	BDL	0.94	430	BDL	0.71	7	37	17	28	BDL	BDL	1100	BDL	BDL	BDL	BDL	210
20	Ben Butler Mine	3.2	4	2.5	530	BDL	1	50	34	3000	208	BDL	BDL	1300	BDL	BDL	BDL	13	71000
21	Boston Mine	0.66	BDL	0.29	120	BDL	0.67	BDL	48	100	6	BDL	BDL	560	BDL	BDL	BDL	BDL	710
22	Red Cloud Mine	0.82	BDL	0.57	110	BDL	0.67	BDL	54	4300	20	BDL	BDL	550	BDL	BDL	BDL	BDL	7500
23	Eagle Chief Mine	2.9	18	4.9	16000	BDL	0.92	12	BDL	4700	51	BDL	BDL	2800	BDL	BDL	BDL	BDL	39000
24	Riverside Mine	0.86	BDL	0.58	160	BDL	0.93	BDL	23	24	4.8	BDL	BDL	950	BDL	BDL	BDL	BDL	330
25	North Composite-Columbus Group	0.78	3	0.75	460	BDL	0.87	BDL	27	1500	11	BDL	BDL	1400	BDL	BDL	BDL	BDL	4900
Duplicate Extract 25	North Composite-Columbus Group																		
26	Southwest Composite-Columbus Group	0.54	BDL	0.43	110	BDL	0.89	BDL	BDL	6900	7.8	BDL	BDL	650	BDL	BDL	BDL	BDL	5100
27	Southeast Composite-Columbus Group	1	BDL	0.65	420	BDL	0.81	BDL	BDL	1400	7.3	BDL	BDL	1200	BDL	BDL	BDL	BDL	2100
27A	Composite Along Stream-Columbus Group	0.86	2	0.85	260	BDL	0.83	BDL	BDL	1800	14	BDL	BDL	1400	BDL	BDL	BDL	BDL	5200
28	Mill Tailings above Grouse Gulch	2.7	BDL	0.67	23	BDL	1	BDL	BDL	3200	28	BDL	BDL	2600	BDL	BDL	BDL	BDL	12000
29	Unknown Mine South of Grouse Gulch	2.4	6	0.62	95	BDL	0.95	BDL	BDL	BDL	5	BDL	BDL	1900	BDL	BDL	BDL	BDL	120
30	Toltec Mine	1.6	3	4.7	1500	BDL	0.8	5	BDL	BDL	71	BDL	BDL	1300	BDL	230	BDL	BDL	2600
31	Unknown Mine near Picayune Gulch	1.2	BDL	0.49	300	BDL	0.91	BDL	BDL	170	5.5	BDL	BDL	1400	BDL	BDL	BDL	BDL	330
32	Silver Wing Mine	0.3	10	2.7	21000	BDL	1.1	35	77	2500	160	BDL	BDL	3200	BDL	130	BDL	BDL	16000
33	Tom Moore Mine	0.25	14	4.9	34000	BDL	1	26	BDL	1000	301	BDL	BDL	2200	BDL	BDL	BDL	BDL	58000
34	Sioux City Mine	0.62	BDL	0.75	1400	BDL	0.89	5	BDL	5600	39	BDL	BDL	2300	BDL	BDL	BDL	BDL	12000
36	Silver Bell Mine	0.15	BDL	0.47	70	BDL	0.9	BDL	BDL	100	28	BDL	BDL	2100	BDL	BDL	BDL	BDL	460
37	Protection Mine	1.7	6	2.9	7800	BDL	0.97	6	BDL	250	68	BDL	BDL	3400	BDL	110	BDL	BDL	18000
38	Senator Mine	0.68	2	1.6	1600	BDL	0.9	BDL	BDL	32	19	BDL	BDL	2600	BDL	BDL	BDL	BDL	830
39	Treasure Mountain Mine	1.2	2	1.18	1400	24	1	5	26	260	5.1	BDL	BDL	2600	BDL	BDL	1	1.6	630
40	Golden Fleece Mine	0.2	4	2	12	BDL	0.88	17	BDL	BDL	73	BDL	BDL	2000	BDL	BDL	BDL	BDL	1100
41	Unknown Prospect in Picayune Gulch	1.8	BDL	0.4	87	BDL	0.97	BDL	BDL	BDL	5.8	BDL	BDL	1200	BDL	BDL	BDL	BDL	23
42	Sound Democrat Mine	0.67	BDL	0.59	910	BDL	0.9	BDL	31	BDL	5.9	BDL	BDL	1600	BDL	BDL	BDL	BDL	310
43	Mine West of Columbus Group	0.56	BDL	0.52	79	BDL	0.82	BDL	BDL	790	4.9	BDL	BDL	1100	BDL	BDL	BDL	BDL	870
Picayune Soil	Vegetated Soil	2.1	BDL	0.56	27	BDL	1.3	BDL	BDL	BDL	1.9	BDL	BDL	650	BDL	BDL	BDL	BDL	14
Burrows Gulch Soil	Vegetated Soil	0.89	BDL	0.63	42	BDL	1.3	BDL	BDL	BDL	1.5	BDL	BDL	630	BDL	BDL	BDL	BDL	20
Burns Gulch Talus	Mixed Talus and Mine Waste	0.9	BDL	0.46	110	BDL	1.1	BDL	BDL	60	2.4	BDL	BDL	860	BDL	BDL	BDL	BDL	230

APPENDIX 2

COLORADO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINERALS AND GEOLOGY

SAMPLING AND ANALYSIS PLAN
NON POINT SOURCE PROGRAM
ANIMAS RIVER TARGETING CONTINUATION PROJECT
UPPER ANIMAS WATERSHED - SILVERTON MINING DISTRICT
SAN JUAN COUNTY, COLORADO

STATE OF COLORADO
NIL SINE NUMINE
1876

Prepared by
James T. Herron

Approved: ______________________ Date: 6/5/97

Brent Truskowski, NPS Colorado Project Officer, EPA

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SAN JUAN COUNTY, COLORADO

1.0 INTRODUCTION

The Division of Minerals and Geology (DMG) of the Colorado Department of Natural Resources (CDNR), in cooperation with the U.S. Environmental Protection Agency (EPA), and Colorado Department of Public Health and Environment (CDPHE) will coordinate the Animas River Targeting continuation Project within the Clean Water Act, Section 319, Non Point Source Program (NPS) in the Upper Animas watershed, Silverton Mining District, San Juan County, Colorado. The NPS project will provide data which will enable feasibility investigations and pre-engineering evaluations in Cement Creek to identify sites that will be considered for remedial projects designed for water quality improvements to meet the goals for attaining aquatic life uses in the Basin.

Field work for this NPS project is scheduled to be conducted as a one sampling event scheduled for the week of September 4, 1997, and July 1998. The date for the 1998 sampling will be determined by snowpack conditions and forecasted weather conditions. This SAP is prepared to guide field operations and to outline the analytical objectives for the NPS sampling project. This SAP will evaluate aqueous sources identified by the DMG during reconnaissance investigations in 1997.

This SAP calls for the collection of up to 66 field samples including 36 surface water samples, 24 aqueous source samples (draining mines), and 6 opportunistic samples. In addition, the sampling team will provide quality assurance/quality control samples consisting of field blanks, trip blanks, rinsate blanks, and duplicate samples.

A field screening of mining waste piles will be done during the August 1997 reconnaissance investigation. The field screening will be done to determine which waste piles should be investigated further. Up to 65 samples will be collected from waste piles throughout the basin. The field screening will be done following the procedures developed during similar sampling in Cement Creek.

The field screening procedure is as follows: Waste rock and soil/outcropping samples are collected from a minimum of ten locations at each site using HCl-washed 100 ml polyethylene beakers to remove the top two inches of material.

The 10+ sub-samples from each site are then composited in a 1-gallon re-closable plastic bag. The composited samples are thoroughly mixed in the field by inverting the bag numerous times. After mixing, 150 ml of sample is removed and placed in a 1 liter polyethylene beaker along with 300 ml of deionized water. The wetted sample is then vigorously stirred for 15 seconds, covered, then left to settle for 90 minutes. Ninety minutes is the amount of time it takes for the clay fraction to settle to the bottom of the beaker.

After 90 minutes, the liquid is filtered through very fine grade soil filters (approximately 2 micron). A portion of the liquid is used to measure the total acidity, pH, specific conductance, and sulfates. The remaining liquid is acidified with nitric acid for possible lab analysis. Total acidity is determined using a Hach digital titrator to reach a phenolthalein end-point. Specific conductance and pH will be measured with a HyDAC instrument. Sulfates will be measured using a Hach DR700 Colorimeter, following the EPA approved procedures in the manual.

The remaining sample will be kept in the original ziploc bag for future analysis, if needed. The Animas River Targeting Project is being done at the direction of the Animas River Stakeholders Group (ARSG). ARSG is a collaborative effort involving a wide range of public and private interests with the mission of improving water quality and aquatic habitats in the Animas Watershed. Stakeholders include federal and state agencies, local government, the mining industry, individual land owners, environmental and citizens groups, residents, and others.

2.0 OBJECTIVES

The upper Animas River has been included in the *Animas River Targeting Project*, initiated by the CDPHE Water Quality Control Division in 1991. The 1997 project is intended to complete feasibility investigations and pre-engineering evaluations in the Animas River above the townsite of Eureka. The portion of the Animas river between Eureka and Silverton will be investigated at a later date. The NPS project includes sampling of surface water and aqueous mine waste source areas.

This SAP is for water samples and non-analytical data needed to quantify contribution of metals from individual mine sources into Cement Creek, and comparative data on mining wastes to ascertain which sites should be remediated.

This SAP is intended to fulfill the following objectives for further evaluation of the basin:

- Characterize mine drainages located in the upper Animas River through the collection and analysis of source samples.

- Characterize and evaluate mining waste sources located in the upper Animas River through the collection and analysis of leachate water emitting from the waste piles, on an opportunistic basis, and through field screening in August 1997.

- Evaluate the impact to surface water through the collection and analysis of surface water samples.

- Identify sites that will be considered for water quality improvement.

3.0 BACKGROUND INFORMATION

3.1 LOCATION AND SITE DESCRIPTION

The portion of the Animas River studied in the Animas River Targeting Project is located near the City of Silverton, Colorado. The City of Silverton is situated at an elevation of 9,305 feet above mean sea level (M.S.L.). Previous feasibility investigations under the Animas River Targeting Project have been completed on Mineral Creek and Cement Creek, which are the major tributaries to the Animas River. Historic mining in the area took place throughout Cement Creek and its tributaries.

San Juan County and the City of Silverton are located in southwestern Colorado, approximately a 7-hour drive from Denver. The area can be reached by driving south on Interstate 25 to Walsenburg, then west on Highway 160 to Durango, then north on U.S. Highway 550, taking Colorado State Highway 110 into Silverton. Follow Highway 110 through town, and turn north onto Cement Creek Canyon Road at 17th Street.

3.2 SITE HISTORY AND PREVIOUS WORK

The discovery of gold in Arrastra Gulch brought miners to the Silverton area in the early 1870's. The discovery of silver in the base-metal ores was the major factor in establishing Silverton as a permanent settlement. Between 1870 and 1890, the richer ore deposits were discovered and mined to extent possible. Not until 1890 was any serious attempt made to mine and concentrate the larger, low-grade ore bodies in the area. The North Star mine constructed a mill on Sultan Mountain (approximately 1 mile southwest of Silverton) and between 1894 and 1897; a nearby matte smelter processed up to 100 tons of ore per day (CDH, 1994a).

The Kendrick and Gelder smelter was built near the mouth of Cement Creek in 1900 and operated during the summer months until 1905. Regional low-grade ores containing gold, silver, lead and zinc were processed at 12 concentration mills in the valley, and further refined at the K&G Smelter. Approximately 5,500,000 pounds of copper matte from the upper levels of the Henrietta mine, located in Prospect Gulch, was developed at the K&G smelter. The K&G Smelter was operated by the Ross Mining and Milling Company in 1906 and 1907, chiefly for copper ores from its mines. Mining and milling slowed down circa 1905, and mines were consolidated into fewer, larger operations with the facilities for milling large volumes of ore (CDH, 1994a).

The upper Animas River contains many historic mines. The Lucky Jack and London Mines are located above the Ghost Town of Animas Forks. The Mountain Queen, Bagley Tunnel, and Columbus Mines are located in California Gulch. The Gold Prince and Silver Queen Mines are located in Placer Gulch. The Hidden Treasure Mine is located in Picayune Gulch. The Silver Wing, Toltec, and Tom Moore mines are located on the mainstem between Eureka and Animas Forks (DMG, 1995a&b).

3.2.1 Previous Investigations

A Preliminary Assessment was conducted regarding the Kendrick & Gelder Smelter by the Colorado Department of Health in 1994 (CDH, 1994a). Site Investigations and related surface water sampling were conducted at both the Sunnyside Mine at Gladstone, in Cement Creek Basin, as well as at the Mayflower Mill, located approximately 1.5 miles north of Silverton, by the Colorado Department of Health in 1984. Surface water sampling of Cement Creek, fifty feet above and below the Sunnyside Mine, above the confluence with South Fork, indicated levels of heavy metals including cadmium, lead and silver, above drinking water standards (CDH, 1984a&b).

The Animas River is included in the *Animas River Targeting Project*, initiated by the CDPHE Water Quality Control Division in 1991. The project consists of monitoring the chemical, physical and biological health of the Upper Animas River Basin to determine what improvements to aquatic life uses might be attained. Synoptic water quality monitoring at 200 sites within the Upper Animas, Cement and Mineral Creek basins were conducted on four occasions, September 1991, June 1992, October 1992 and July 1993. Biological assessments, conducted at selected sites in the upper basin in October 1992, found that aquatic life is not supported in the Cement Creek basin, the Animas River above Maggie Gulch, and the mainstem and Middle Fork of Mineral Creek. Lack of aquatic life is attributable both natural and anthropogenic factors contributing to dissolved aluminum, cadmium, copper, and zinc present in the Animas River basin in concentrations both acutely and chronically to most forms of aquatic life. Additionally, ferric iron, coming from Cement Creek and Mineral Creek forms a deposit on the Cement Creek streambed as well as in the Animas river between Cement Creek and Elk Creek, further inhibiting aquatic life (CDPHE, 1994).

During September-October, 1994, the U.S. Geological Survey, in cooperation with the Colorado Department of Public Health and Environment analyzed drainage from natural springs for comparison with mine drainage, in Ohio and Topeka Gulches, tributaries to Cement Creek. Mines had similar concentrations and loads of dissolved metals compared to naturally occurring springs and streams in Topeka Gulch (USGS, 1995).

Concurrent water quality monitoring will be done by Sunnyside Gold Corporation (SGC), the U.S. Geological Survey (USGS), U.S. Bureau of Reclamation (USBOR), and Colorado River Watch. SGC has bulkheaded the American and Terry Tunnels to stop metal laden water from exiting the tunnels. In order to offset any potential degradation of water quality in Cement Creek and the Animas River, SGC and CDPHE have agreed to a plan that includes injecting alkaline water into the mine pool, mitigating at least six mine sites throughout the upper Animas Basin to reduce metal loading to the Animas River below Silverton. SGC will also treat a portion of the flow in Cement Creek from above the American Tunnel until all mitigation work is completed in order to create a water quality "cushion" for the Animas River Below Silverton. This work has been ordered by the District Court in a Consent Decree in return for the Water quality Control Division not permitting any seeps or springs that may result from mine closure activities.

In order to evaluate the effects of bulkheading the American and Terry Tunnels, SGC has been monitoring both natural seeps and mine drainages in the Cement Creek and Animas River drainages in advance of closing the valves of the bulkheads. SGC will continue monitoring the seeps and springs and Cement Creek above and below the American Tunnel treatment plant monthly. SGC will also monitor receiving streams above and below four of the six mitigation project sites during high flow and low flow periods prior to and for two years following remediation.

The Colorado River Watch Program conducted by the Silverton Public Schools will continue to monitor water quality at the Cement Creek, Mineral Creek and Animas River gauges on a regular basis. The USBOR will monitor the same sites on an alternating schedule with SGC.

3.3 SITE GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

3.3.1 Geology

The Animas River Basin is located on Quaternary, glacial moraine deposits, of the Pinedale and Bull Lake Glaciation. These surface deposits overlie Tertiary, andesitic lavas of the Eureka Rhyolite.

The area underwent relatively continuous sedimentary deposition in the Paleozoic, from Cambrian to Permian. Deposition continued into the Mesozoic, with apparent regularity over most of the area. Near the end of the Mesozoic, the area was uplifted, and subjected to deep erosion. Sedimentary rocks are preserved, and exposed primarily to the southwest of Silverton. Beginning in the late Cretaceous to early Tertiary, the first of many periods of intrusive and volcanic activity began which characterizes the Tertiary history of the San Juan Mountains. The dominant feature in the area is the mid-Tertiary, Silverton Caldera. Fractures related to the subsidence of the caldera, control ore deposition in many of the Silverton mining areas. Intrusive activity, and faulting (followed by the formation of the major ore bodies) continued in the later Tertiary (Miocene or later).

Metalliferous deposits are of three general types: veins, replacement bodies, and disseminated. Veins are of the complex-sulfide type. Pyrite ($FeS2$), galena (PbS), sphalerite (ZnS) and chalcopyrite ($CuFeS2$), occurring in a gangue of quartz, and minor calcite are the most abundant vein materials. Gold and argentiferous galena have accounted for most of the value. Tetrahedrite (($CuFe)12Sb4S13$) is locally abundant and often carries considerable silver. Visible free gold is very rare in this area.

Surficial materials of Pleistocene, and Recent age can be divided into four groups: glacial till (the most extensive), alluvium, talus, and landslide material. Glacial moraine deposits are typified by silty, clayey gravels, with cobbles and boulders.

Soils associated with the Animas River are shallow and vary from well to poorly drained. The soils have slow infiltration rates when thoroughly wet, and slow rates of water transmission (CDPHE, 1994a).

3.3.2 Hydrogeology

Shallow, unconfined aquifers in the area are alluvial, associated with Cement Creek and the Animas River, and glacial moraine deposits. These deposits overlie bedrock, composed of Tertiary, andesitic lavas, related to the formation of the Silverton Caldera. There is some indication of the depth to ground water for the bedrock aquifers has been modified by drainage tunnels and adits constructed to de-water the mines (CDH, 1994a).

Three wells have been identified as being used for household or domestic purposes in the Cement Creek Basin: one at the mouth of South Fork, one at the head of South Fork and one at the mouth of Cement Creek; well depths and water levels are not recorded. Three wells on the mainstem of the Animas River below Howardsville, approximately 3 miles northeast of Silverton, have been identified as being used for household or domestic purposes. One was reported to be drilled to a depth of 10 feet. Two monitoring wells were drilled by the City of Silverton, located along the Animas River within city limits, are reported having depths to water of 20 and 40 feet. Two wells are located along Mineral Creek, above its confluence with the Animas River; the depths to water are recorded at 12 and 35 feet (Colorado Division of Water Resources, 1996). The shallow depths to water of the wells located along the Animas River and Mineral Creek indicate that the wells access the alluvial aquifer.

Groundwater will not be sampled, as it is outside the scope of the NPS Sampling Project objectives.

3.3.3 Hydrology

Regionally, the site is located within the San Juan River Basin, located along the tributaries and the mainstem of the Animas River. The Animas River is located within the Silverton caldera, an extensively mineralized area that has been mined for base and precious metals since the late 1800's (CDPHE, 1995b). The Animas River above Animas Forks exhibits staining by aluminum and zinc oxides.

Biological sampling of fish and macrobenthos conducted by the CDPHE between 1991 and 1993 determined that fisheries exist in the Animas River between Maggie Gulch and Cement Creek; however, aquatic life is not supported in either the Animas River above Maggie Creek or in Cement Creek (CDPHE, 1994).

3.4 PRELIMINARY PATHWAY ANALYSIS

3.4.1 Source Characterization

Byproducts of underground metal mining, commonly referred to as mine waste, generally fall into three categories: waste rock, generated from the extraction of ore; drainage of groundwater from mine workings; and mill tailing, i.e., remnants of crushed ore from which minerals of interest have been processed. Mine wastes may generate two major types of pollutants: acid drainage, with corresponding high concentrations of heavy metals; and metal-laden sediments derived from erosion of waste rock and/or tailings piles. Mine drainage composition is a function of ore deposit geology, climate, and mining methods used. Factors controlling pH and dissolved metal concentration include the acid buffering capacity of the country rock and the abundance of acid-generating sulfide minerals (CDPHE, 1995a).

The DMG NPS sampling effort will collect and analyze 24 aqueous sources i.e., draining mine adits, found throughout the basins:

3.4.1.1 Upper Animas Sources.

Preliminary reconnaissance by the Division of Minerals and Geology in 1992-1995 has identified the following important potential mine sites:

Lucky Jack Mine

The Lucky Jack is a draining mine adit (Site # DM2) located in the upper Animas River Basin, immediately below Engineer Pass. The mine drainage infiltrates into and emerges from the base of the adjacent mine waste pile (DMG, 1995a).

Unknown Mine in Upper Animas Basin

This unknown mine consists of a draining adit (Site # DM1) and adjacent waste pile located northwest of the Lucky Jack Mine. In August 1996, acid drainage was observed to be flowing from the adit and quickly infiltrating the waste rock pile. There was visual evidence that the adit drainage flows into a small tributary during some parts of the year.

Unknown Mine in Upper Burrows Gulch

This unknown mine is located on a talus slope in upper Burrows Gulch (Site # DM3). The adit drainage was observed to quickly infiltrate the surrounding talus and disappear. Numerous springs are present at the bottom of this talus. The mine drainage will be sampled to determine if it contributes metals to the springs.

Unknown Mine in Burrows Gulch

This unknown mine is located immediately south of the London Mine (Site # DM4). In 1996, the mine drainage was observed to infiltrate the waste rock pile and emerge as a spring at the bottom of the waste rock pile.

London Mine

The London Mine consists of three draining mine adits (Site # DM5, DM6 and DM7) and adjacent waste rock pile, on the north side of Burrows Creek (DMG, 1995b). Adits DM5 and DM6 only flow during the spring and early summer. The drainage from adit DM6 forms a pond immediately outside the adit.

Prairie Mine

The Prairie Mine consists of a draining mine adit (Site # DM8) and adjacent waste rock pile. The adit is adjacent to the Burrows Gulch access road approximately 200 yards east of the London Mine.

Unknown Mine Below Burrows Gulch

This mine consists of a small draining adit and waste rock pile on the west bank of the Animas River below Burrows Gulch (Site #DM9). The adit was observed to be seeping into the waste rock pile in 1996. This mine site will likely only be sampled during the high-flow period.

Mountain Queen Adit

The Mountain Queen adit is located near the headwaters of California Gulch (Site # DM10) and adjacent waste rock pile. The mine drainage flows onto the waste rock pile, then splits into two separate streams, flowing on both sides of the waste rock pile.

Unknown Mine Complex in California Gulch

This mine complex consists of a four draining mine adits (Sites # DM11, 12, 13, and 14) and adjacent waste rock piles. All four adits are located along the same vein structure on the north side of California Gulch. The four adits have been observed to drain during the high-flow period, but are suspected to flow through fracture systems at all times of the year. The lower two mine adits are accessible by an old road. The upper two adits are only accessible by foot.

Unknown Mines (Old A-17a and A-17b)

These mine adits (Sites # DM15 and 16) are located on the north side of California gulch immediately east and below the complex of four adits discussed above. Both adits flow perennially, infiltrating into the adjacent waste rock piles and surfacing as springs above the California Gulch Road. It is suspected that a portion of the flow from these mines flows through fracture systems and surfaces as springs below the mine site.

Vermillion? Mine
This mine (Site # DM17) is located in a circular bowl approximately 600 feet in elevation above and north of the California Gulch Road. The mine is accessible only by foot. A trail to the mine leads from the last switchback in the road to site #DM13. The mine drains across a portion of the waste rock pile and joins a small tributary to California Gulch. A portion of the flow from this tributary passes through the waste rock. A large area of vegetation has been killed below the mine.

Silver? Mine
This mine site has been monitored previously by CDPH&E as site # A-16. The adit drains (Site # DM18) into a pond, then through the waste rock pile, then flows along the road ditch to a small tributary of California Gulch. The site is located north of the California Gulch road west of the confluence with Placer Gulch. Based upon past monitoring, this drainage is a minor source of metals to California Gulch, but needs to be sampled for loading analysis of California Gulch.

Bagley Tunnel
This site consists of a draining mine adit (Site # DM19) and adjacent waste rock piles. A large mill structure is located on the east side of the waste rock pile. The waste rock pile is bisected by the California Gulch road. The adit is located north of the road. The mine drainage from this site is piped from the adit over the waste rock, and discharged south of the road.

Columbus Mines
The Columbus mine consists of a draining mine adit and adjacent waste rock piles near the confluence of California Gulch and the Animas River (Site # DM20). The mine drainage infiltrates into the waste rock and emits as a spring at the toe of the pile.

Silver Wing Mine
This mine site consists of a draining mine adit (Site # DM21) and adjacent waste rock pile. The mine site is located below Burns Gulch on the mainstem of the Animas. The site is accessed by an old wooden bridge.

Tom Moore Mine
This mine site consists of a draining mine adit (Site # DM22) and adjacent waste rock pile. The mine is located along the mainstem of the Animas River approximately 1/4 mile below the Silver Wing, opposite the Animas road.

Unknown Mine South of Eureka
This mine site consists of a draining mine and adjacent waste rock pile (Site # DM23). The mine adit only drains most years only during the high-flow period.

Unknown Mine North of Eureka
This mine is located on the talus slope being mined by San Juan County for road surfacing material. The mine site consists of a draining mine and associated waste rock pile (Site # DM24). The high-iron mine drainage flows over the waste rock and infiltrates into the talus material. There is no visible surfacing of the mine drainage below the mine.

3.4.2 Ground Water Pathway Analysis

The nearest ground water wells identified for use as domestic or household purposes are located near Howardsville approximately 2 miles downstream from the lowermost sampling site. Three wells have been identified on the mainstem of the Animas River below Howardsville, approximately 3 miles northeast of Silverton. One was reported to be drilled to a depth of 10 feet. These wells appear to be installed into the surficial alluvial aquifer of the various tributaries of the Animas River (Colorado Division of Water Resources, 1996). Groundwater wells will be sampled by CDPHE-HMWMD.

3.4.3 Surface Water Pathway Analysis

Previous studies have documented the release of metal contaminants to surface water in the Animas River (CDPHE, 1994). Primary targets within 15 downstream miles include fisheries, and wetlands. Previous studies have included a limited number of analytes and no sediment analytical data is available. The City of Silverton obtains its municipal drinking-water from Bear Creek in the Mineral Creek Watershed and Boulder Creek, upstream of the SGC Mine tailings (CDPHE, 1995b).

It has been reported that minimal aquatic life was found in the Animas River from below the confluence of Cement Creek to Elk Creek, approximately 6 miles south of Silverton, due to metals loading and cementation of stream substrate associated with both natural mineralization as well as historic mining activities (CDH, 1994).

An evaluation of segments of the Animas River Basin by the Colorado WQCD for a rule making hearing states that "significant metal loading occurs in the three watersheds that converge near Silverton: the Animas headwaters, Cement Creek and Mineral Creek. The mainstem of the Animas above Elk Creek, Mineral Creek from it headwaters to the confluence with south Mineral Creek, and the entire Cement Creek watershed lack the aquatic life classification and water quality standards for metals. Cement Creek has the poorest water of the three watersheds. Low pH water throughout the watershed, in the range of 3.0 to 5.5, mobilizes aluminum, cadmium, copper, iron, manganese, and zinc. Aluminum, copper and zinc are readily precipitated, forming bottom deposits as the stream pH increases. Most of the zinc loading is from the upper part of the watershed, but high concentrations of zinc are found throughout the Cement Creek" (CDH, 1994b).

The WQCD recognized that achievement of full aquatic life uses thoughout the basin is probably not possible. However, opportunities to reduce metal loads within the watersheds to improve water quality for aquatic life in the mainstem of the Animas River between Maggie Gulch and Elk Creek is reflected in the Division's water quality recommendations for the 1994 triennial review (CDH, 1994b).

Surface water samples will be collected at up to 65 locations and analyzed for total and dissolved metals, as specified in Table V. Tables I and II provide the sample type, identification number, location and rationale for samples collected in Cement Creek and Prospect Gulch, respectively. Figures 1-3 illustrate sample locations.

Federally listed endangered species that could occur at, or visit, the area include the Northern Gos Hawk (*Accipiter gentilis*) and the Boreal Toad (*Bufo borealis*) (USFWS, 1995).

3.4.4 Soil Exposure Pathway

There are no persons living on-site or within 200 feet of any of the identified sources. The sources located along the upper Animas River are greater than one-mile from the nearest residents. The risk posed to human health or the environment by the on-site pathway for the sources identified is considered to be minimal.

4.0 FIELD PROCEDURES

4.1 CONCEPT OF OPERATIONS

4.1.1 Schedule

The sampling events are scheduled for September 4, 1997 and July 1998. Due to extreme avalanche danger, no sampling is anticipated for the winter months. The September sampling will likely not include some of the draining mines. Several of the draining mines have been observed to be dry during the low-flow period. All sites are anticipated to be sampled during the July 1998 sampling. Up to five opportunistic samples have been included for collection from previously undocumented sources.

4.1.2 Safety

The NPS Sampling project will be conducted by several DMG teams which will consist of 2-4 persons and will include a Site Safety Officer. Protective clothing and powderless gloves will be worn during all sample collection. It is expected that most site-related activities can be accomplished in Level D personal protective equipment (PPE). PPE will be upgraded to Level C if site conditions warrant. If Level B becomes necessary, the field team will temporarily cease operations until the Site Safety Officer can arrange for this type of protection.

4.1.3 Site Access and Logistics

Access to all sample locations will be coordinated by the project manager. Efforts will be made to obtain consensual access through the various property owners for all sample locations.

4.2 SAMPLE LOCATIONS

This SAP calls for the collection of up to 66 field samples including: 24 aqueous source samples (draining mine adits), 36 aqueous surface water samples and 6 opportunistic samples. In addition, the sampling team will provide up to 18 quality assurance/quality control samples consisting of field blanks and duplicates (Table II).

Table I describes the sample type, identification number, location, and rationale for each sample in the Upper Animas River Basin. Figures 1 and 2 illustrate the water sample locations. Figure 3 illustrates the proposed mining waste sample locations.

4.3 SAMPLING METHODS

All samples will be collected in accordance with protocols identified in the *QAPP for the Colorado Nonpoint Source Monitoring Program (9-8-94)*. Measures will be taken to minimize the amount of in-field equipment decontamination required for the sampling event. Sampling equipment will be decontaminated prior to the sample event. Equipment which will be reused will be decontaminated in the field. Decontamination will be achieved by washing with a non-phosphate detergent and triple rinsing with deionized water.

Water samples for dissolved metals analysis will be field filtered with a 0.45 micron filter into the sample container and then preserved at a pH of 2 with nitric acid. Water samples for total metals analysis will be preserved at a pH of 2 with nitric acid. In-field measurements of pH, conductivity, and temperature, and flow will be made for all water samples in accordance with the QAPP.

Where possible surface water samples will be collected directly into the sample containers. Where the sample cannot be directly collected in the sample bottle (principally dissolved metals samples), a clean 1-liter wide-mouth bottle will be used for collection. Sampling will progress from a downstream location to an upstream location to eliminate sediment disturbance in subsequent samples. Surface water samples will be collected by immersing the sample bottle several inches beneath the water surface with the mouth of the sample bottle facing upstream. A separate surface sample may be collected if immiscible fluids are observed. To collect such a sample, the sample container will be inverted, lowered to the approximate sample depth and held at about a 45-degree angle with the mouth of the bottle facing downstream.

If surface water samples cannot be collected directly into the sample container, a decontaminated 1-liter bottle will be used to collect the sample. Care will be taken to avoid excessive agitation when transferring samples to the sample containers.

Flow measurements will be obtained for all surface water sample locations except for samples located at the mouth of Cement Creek, Mineral Creek and in the Animas River above and below Cement Creek and below Mineral Creek where flow will be determined based upon a reading from the gauging station.

4.4 CONTROL OF CONTAMINATED MATERIALS

The sampling team will dispose of all wastes produced during the investigation in accordance with EPA document 540-G-91-009 entitled *Management of Investigation-Derived Wastes During Site Inspections*. Disposable sampling equipment, rubber gloves, and protective outerwear will be decontaminated, bagged, removed from the Site and disposed of as a non-hazardous solid waste. Detergent solutions for decontamination will be collected in polyethylene bottles and disposed of at the field laboratory in Silverton. Rinsate water will be allowed to flow onto the ground at the site.

4.5 ANALYTICAL PARAMETERS

Table I describes sample identification, type, location, and rationale for each sample from the Upper Animas River Basin. Tables II presents the Sampling Plan Check List specifying analyses to be performed on each sample.

Analysis will be performed EPA's Technical and Management Services-Laboratory. Samples will be analyzed for the inorganic Target Compound List (TCL) analytes contained in Table III.

4.6 NON-ANALYTICAL DATA COLLECTION

The following non-sampling observations and data will be obtained:

- Satellite Coordinate Lat/Long determination for all sample locations using a hand-held GPS unit.
- Stream flow measurements for all surface water sample locations on the Upper Animas River using current meters and cutthroat flumes.
- Verify and photodocument extent of wetlands for surface water pathway.

5.0 FIELD QUALITY CONTROL/QUALITY ASSURANCE

The Quality Assurance Project Plan for the Colorado Nonpoint Source Monitoring Program (QAPP) dated September 8, 1994 and approved by EPA on June 25, 1996 will be adhered to. Sample bottles will be purchased commercially, will meet EPA specifications, and will be part of the quality control program. The sample containers to be used for this NPS Sampling project will be 250 milliliter polyethylene bottles for surface water and aqueous source samples (total recoverable metals, dissolved metals, and Lab Group C analytes).

The following types of samples will be provided for QA/QC purposes:

Rinsate blanks will be collected in the field using analyte-free water from decontaminated equipment as a check for decontamination procedures. One rinsate blank will be collected for each day sampling equipment is decontaminated in the field (at the rate of one per 20 samples).

Field blanks will be prepared for each day of sampling at the rate of one per 20 samples.

One duplicate water matrix water sample will be collected per 20 samples shipped to determine accuracy and precision in laboratory analytical procedures and sample collection procedures.

Rinsate blanks, field blanks, and duplicates will be submitted with separate sample ID's as blind samples.

6.0 CHAIN OF CUSTODY

All samples will be handled in strict accordance with chain of custody protocol prescribed by the *NEIC Procedures Manual for the Evidence Audit of Enforcement Investigation by Contractor Evidence Audit Teams,* April 1984 (EPA-300/9-81 003R). Documentation of sample storage and shipment will be included as part of the chain-of-custody procedures.

7.0 REPORTING

Records will be kept of actual sample locations and-sample points will be accurately located on topographic maps using the measured Latitude/longitude. Procedures will provide documentation of changes in sample locations as they occur in the field due to unanticipated site conditions. Sample locations and sample collection procedures will be documented through the keeping of a field notebook and photographs. Following completion of all field activities, a Sample Activities Report (SAR) will be prepared to document sampling activities and to precisely identify sample locations. Upon receipt of analytical data, Results will be compiled in a report, and used for identifying which mine sites will be considered for reclamation to improve water quality in the basin.

8.0 REFERENCES

Colorado Department of Health, 1984. *Site Inspection Report for the Standard Metals Mayflower Mill*, EPA ID Number COD041093501. June.

Colorado Department of Health, 1984. *Site Inspection Report for the Standard Metals Sunnyside Mine*. EPA ID Number COD000716662. June.

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CDPHE - Colorado Department of Public Health and Environment, Water Quality Control Division, 1994. *Memorandum Regarding Draft Report, Animas River Loading Analysis*. December 30.

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Colorado Division of Water Resources, 1996. *Groundwater Well Permit Data Base*, February 29.

DMG - Colorado Division of Minerals and Geology, 1995a. *Reconnaissance Feasibility Investigation Report. Upper Animas River Basin*. March.

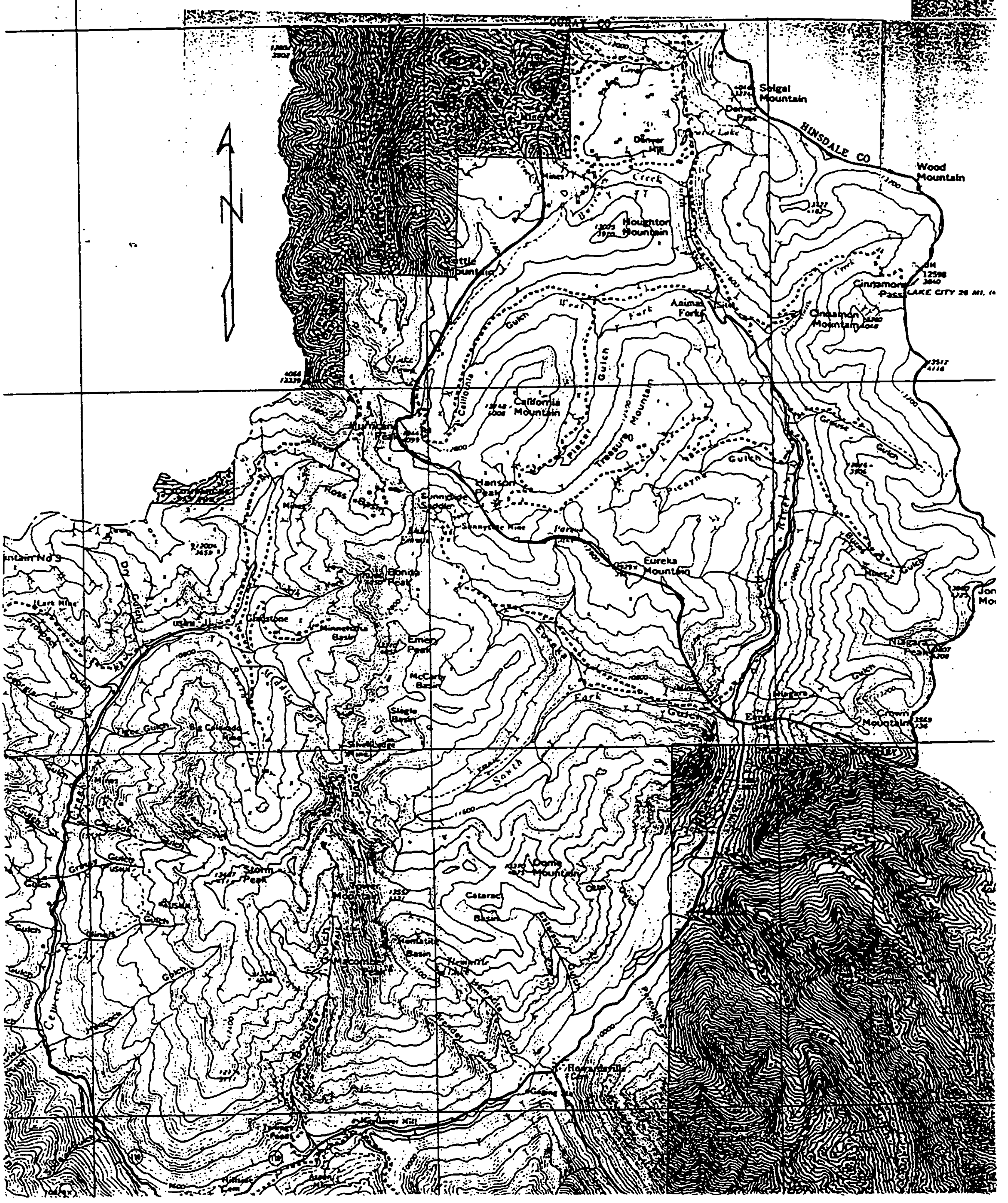
DMG, 1995b. *Animas River Targeting Continuation Project.* Fiscal Year 1996.

District Court, City and County of Denver, State of Colorado, 1996. *DRAFT Consent Decree and Order. Case No. 94 CV 5459. Sunnyside Gold Corporation, Plaintiff v. Colorado Water Quality Control Division of the Colorado Department of Public Health and Environment, Defendant.*

USFWS - U. S. Fish and Wildlife Service, 1995. *Letter to the Colorado Department of Natural Resources, Division of Minerals and Geology in partial fulfillment of NEPA.* Received April.

U.S. Geological Survey, 1995. *Naturally Occurring and Mining Affected Dissolved Metals in Two Subbasins of the Upper Animas River Basin, Southwestern Colorado.* Fact Sheet FS-243-95. December.

FIGURE 1 - Portion of the Upper Animas Watershed to be Sampled



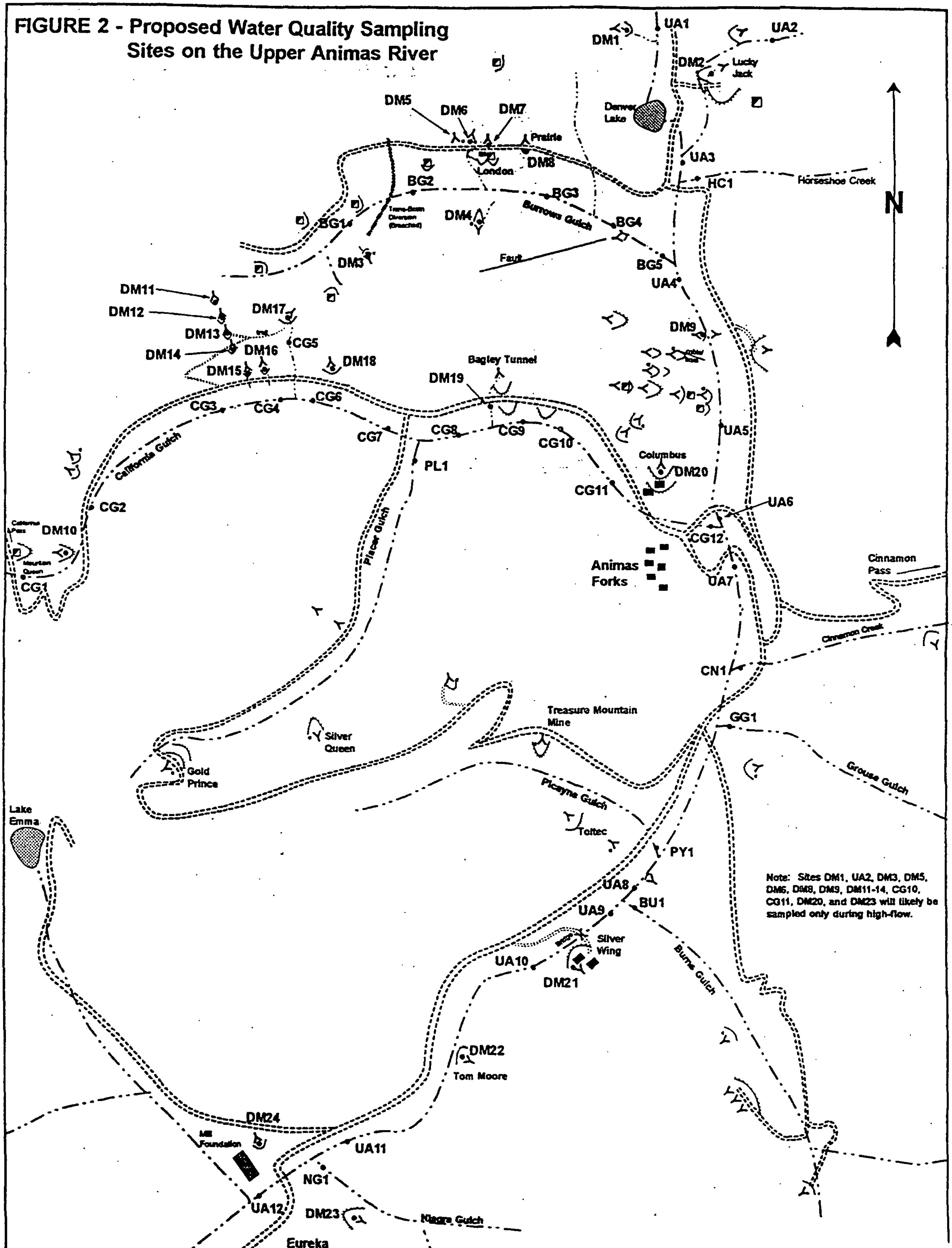


FIGURE 2 - Proposed Water Quality Sampling Sites on the Upper Animas River

FIGURE 3 - Proposed Mine Waste Sampling Sites

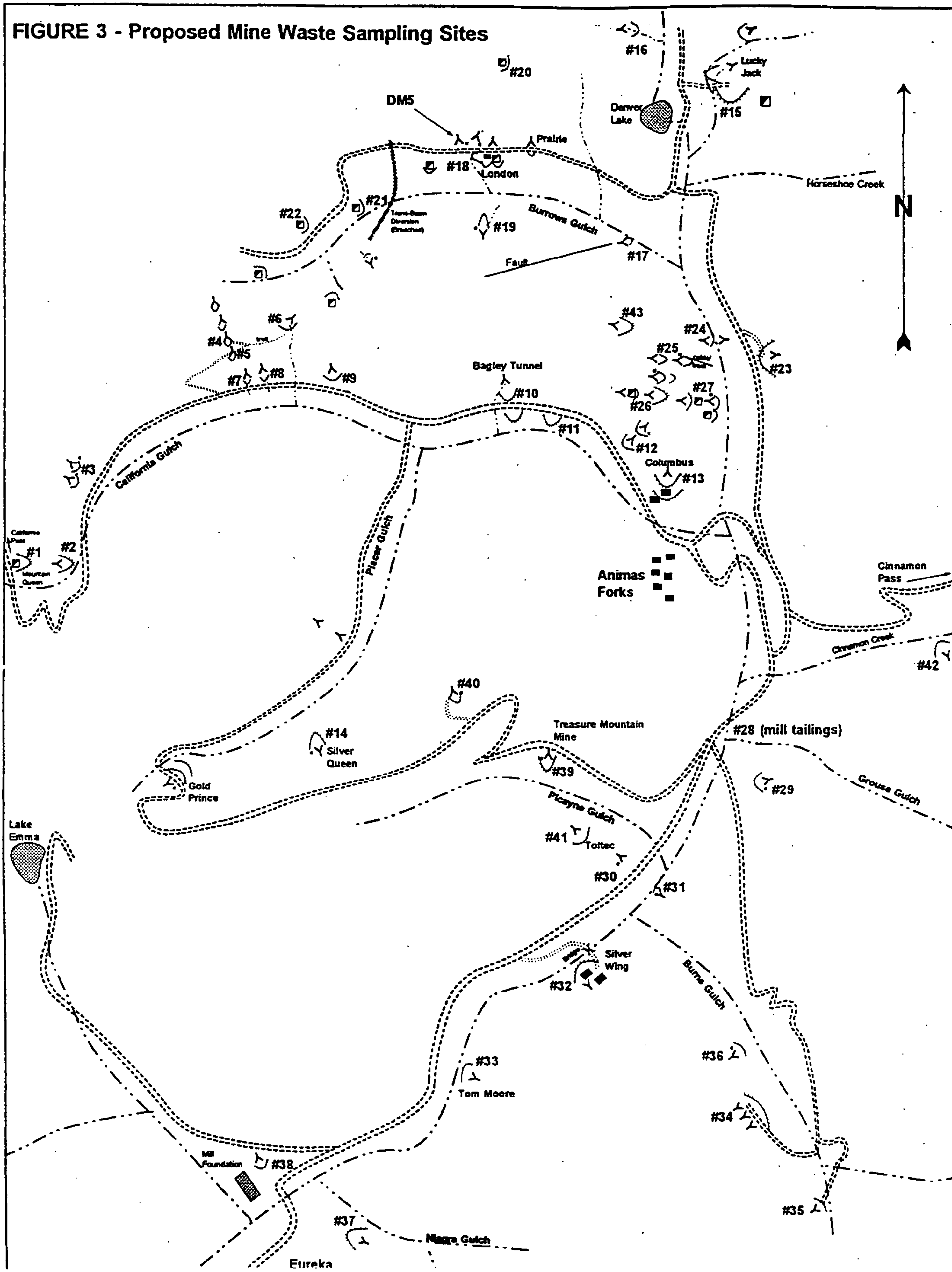


TABLE I: ANIMAS RIVER TARGETING PROJECT - UPPER ANIMAS RIVER BASIN
PROPOSED SAMPLE LOCATIONS

Sample Type	Sample ID No.	Location	Rationale	Non-Sampling Data
Surface Water Samples	UA1	Animas River above draining mine DM1.	To determine background surface water quality for the Animas River.	(1) note observations of stream conditions such as flow rate, color, turbidity, and odor (2) note unusual or poor vegetative growth along surface water bodies (3) note the presence or absence of fish and wildlife in the area (4) note any observations of recreational fishing (5) note the presence of tailings or other potential sources within the surface water (6) note locations and extent of wetlands and sensitive environments (7) take photographs as necessary to supplement documentation of observations
	UA2	Animas River above Lucky Jack Mine.	To determine background surface water quality for the Animas River.	
	UA3	Animas River downstream of draining mines DM1 and DM2.	To assess potential contribution of substances from draining mines and waste pile.	
	UA4	Animas River downstream of Burrows Gulch.	To assess potential contribution of substances from Burrows Gulch and Horseshoe Creek.	
	UA5	Animas River downstream of draining mine DM9.	To assess potential contribution of substances from draining mine DM1 and waste pile complex.	
	UA6	Animas River above confluence with California Gulch.	To assess potential contribution of substances from the mineralized canyon below site UA5.	
	UA7	Animas River below confluence with California Gulch.	To assess potential contribution of substances from California Gulch.	
	UA8	Animas River upstream from Burns Gulch.	To assess potential contribution of substances from Cinnamon Creek, Grouse Creek and Picayune Gulch.	
	UA9	Animas River downstream of Burns Gulch.	To assess potential contribution of substances from Burns Gulch.	
	UA10	Animas River downstream of Silver Wing Mine.	To assess potential contribution of substances from the Silver Wing mine and waste pile.	
	UA11	Animas River upstream of Niagra Gulch.	To assess potential contribution of substances from natural sources and the Tom Moore mine.	
	UA12	Animas River upstroom of Eureka Gulch.	To assess potential contribution of substances from Niagra Gulch, draining mines DM23 and DM24 and waste piles.	

TABLE I: ANIMAS RIVER TARGETING PROJECT - UPPER ANIMAS RIVER BASIN
PROPOSED SAMPLE LOCATIONS

Sample Type	Sample ID No.	Location	Rationale	Non-Sampling Data
Surface Water Samples (continued)	HC1	Horseshoe Creek above the confluence with the Animas River.	To determine surface water quality in Horseshoe Creek above its confluence with the Animas River	
	BG1	Burrows Gulch above draining mines.	To determine background surface water quality in Burrows Gulch.	
	BG2	Burrows Gulch below breached trans-basin diversion.	To assess potential contribution of substances from draining mine DM3 and natural sources to Burrows Gulch.	
	BG3	Burrows Gulch below London Mine.	To assess potential contribution of substances from the London, Prairie, and unnamed mine	
	BG4	Burrows Gulch below intermittent tributary.	To assess changes in water quality due to inflow from a small tributary.	
	BG5	Burrows Gulch above its confluence with the Animas River.	To assess potential contribution of substances from a large fault, and instream waste pile, plus the contribution from Burrows Gulch to the Animas.	
	CG1	California Gulch above the Mountain Queen mine.	To determine background surface water quality.	
	CG2	California Gulch downstream of the Mountain Queen mine.	To assess potential contribution of substances from the Mountain Queen draining mine and waste pile.	
	CG3	California Gulch above beginning of white precipitate on streambed.	To assess potential contributions from a group of small waste piles and to serve as "background" for a large group of mines.	
	CG4	California Gulch downstream of large group of draining mines and waste piles.	To assess potential contribution of substances form a series of draining mines and associated waste rock piles.	
	CG5	Perennial tributary to California Gulch downstream of draining mine DM17 and waste pile.	To assess potential contributions of substances from mine drainage and waste rock.	
	CG6	California Gulch downstream of tributary CG5.	To determine surface water quality in California Gulch below the confluence with tributary affected by draining mine and waste pile	

TABLE I: ANIMAS RIVER TARGETING PROJECT - UPPER ANIMAS RIVER BASIN
PROPOSED SAMPLE LOCATIONS

Sample Type	Sample ID No.	Location	Rationale	Non-Sampling Data
Surface Water Samples (continued)	CG7	*California Gulch upstream of confluence with Placer Gulch.*	*To determine surface water quality of California Gulch above its confluence with Placer Gulch.*	
	CG8	California Gulch below its confluence with Placer Gulch.	To determine surface water quality of California Gulch below its confluence with Placer Gulch.	
	CG9	California Gulch below Bagley Tunnel mine drainage.	To determine surface water quality of Cement Creek below the Bagley Tunnel mine drainage.	
	CG10	California Gulch below Bagley Mill Tailings.	To assess potential contribution of substances from the Bagley Mill Tailings.	
	CG11	California Gulch below group of mine waste rock piles.	To assess potential contribution of substances from a group of waste piles during high-flow period.	
	CG12	California Gulch above confluence with Animas River.	To determine surface water quality of California Gulch above its confluence with the Animas River, and to assess potential contributions of substances from the Columbus mine drainage and waste rock pile.	
	PL1	Placer Gulch above confluence with California Gulch.	To determine surface water quality of Placer Gulch above its confluence with California Gulch.	
	CN1	Cinnamon Gulch above confluence with Animas River.	To determine surface water quality of Cinnamon Creek above its confluence with the Animas River.	
	GG1	Grouse Gulch above the confluence with Animas River.	To determine surface water quality of Grouse Gulch above its confluence with the Animas River.	
	PY1	Picayune Gulch above the confluence with the Animas River.	To determine surface water quality of Picayune Gulch above its confluence with the Animas River.	
	BU1	Burns Gulch above the confluence with the Animas River.	To determine surface water quality of Burns Gulch above its confluence with the Animas River.	
	NG1	Niagra Gulch above the confluence with the Animas River.	To determine surface water quality of Niagra Gulch above its confluence with the Animas River.	

TABLE I: ANIMAS RIVER TARGETING PROJECT - UPPER ANIMAS RIVER BASIN
PROPOSED SAMPLE LOCATIONS

Sample Type	Sample ID No.	Location	Rationale	Non-Sampling Data
Aqueous Source Samples	DM1	Unknown Mine Drainage in upper Animas River.	Source Characterization.	
	DM2	Lucky Jack Mine drainage.		
	DM3	Unknown Mine drainage in upper Burrows Gulch.		
	DM4	Unknown Mine drainage south of London Mine		
	DM5	Unknown Mine Drainage west of London Mine		
	DM6	Western London Mine Drainage		
	DM7	London Mine drainage.		
	DM8	Prairie Mine drainage.		
	DM9	Unknown Mine drainage north of Animas Forks		
	DM10	Mountain Queen Mine drainage.		
	DM11	Unknown Mine drainages in California Gulch		
	DM12			
	DM13			
	DM14			
	DM15			
	DM16			
	DM17	Vermillion? Mine drainage		

TABLE I: ANIMAS RIVER TARGETING PROJECT - UPPER ANIMAS RIVER BASIN
PROPOSED SAMPLE LOCATIONS

Sample Type	Sample ID No.	Location	Rationale	Non-Sampling Data
Aqueous Source Samples	DM18	Silver? Mine drainage	Source Characterization	
	DM19	Bagley Tunnel Mine drainage		
	DM20	Columbus Mine drainage		
	DM21	Silver Wing Mine drainage		
	DM22	Tom Moore Mine drainage		
	DM23	Unknown Mine drainage south of Eureka		
	DM24	Unknown Mine drainage north of Eureka		

TABLE II: SAMPLE PLAN CHECKLIST
ANIMAS RIVER TARGETING PROJECT - CEMENT CREEK BASIN
Upper Cement Creek Basin and the Mainstem of Cement Creek
Page 1 of 4 Pages

Sample Location	Sample Type	Field Parameter					Laboratory Parameters						
		Temp	pH	Cond	Flow	Fe2+/ Fe3+	Total Metals	Diss. Metals	Dup. Tot. Metals	Dup. Dis. Metals	Dup. Anions	Filtered Blank	Blank
UA-1	water	X	X	X	X	X	X	X				X	X
UA-2	water	X	X	X	X	X	X	X					
UA-3	water	X	X	X	X	X	X	X					
UA-4	water	X	X	X	X	X	X	X					
UA-5	water	X	X	X	X	X	X	X					
UA-6	water	X	X	X	X	X	X	X	X				
UA-7	water	X	X	X	X	X	X	X				X	X
UA-8	water	X	X	X	X	X	X	X					
UA-9	water	X	X	X	X	X	X	X					
UA-10	water	X	X	X	X	X	X	X					
UA-11	water	X	X	X	X	X	X	X					
UA-12	water	X	X	X	X	X	X	X	X	X			
BG-1	water	X	X	X	X	X	X	X					
BG-2	water	X	X	X	X	X	X	X					
BG-3	water	X	X	X	X	X	X	X					

TABLE II: SAMPLE PLAN CHECKLIST
ANIMAS RIVER TARGETING PROJECT - CEMENT CREEK BASIN
Upper Cement Creek Basin and the Mainstem of Cement Creek

Sample Location	Sample Type	Field Parameter					Laboratory Parameters						
		Temp	pH	Cond	Flow	Fe2+/ Fe3+	Total Metals	Diss. Metals	Dup. Tot. Metals	Dup. Dis. Metals	Dup. Anions	Filtered Blank	Blank
BG-4	water	X	X	X	X	X	X	X					
BG-5	water	X	X	X	X	X	X	X					
CG-1	water	X	X	X	X	X	X	X					
CG-2	water	X	X	X	X	X	X	X					X
CG-3	water	X	X	X	X	X	X	X					
CG-4	water	X	X	X	X	X	X	X					
CG-5	water	X	X	X	X	X	X	X					
CG-6	water	X	X	X	X	X	X	X					
CG-7	water	X	X	X	X	X	X	X					
CG-8	water	X	X	X	X	X	X	X					
CG-9	water	X	X	X	X	X	X	X					
CG-10	water	X	X	X	X	X	X	X					
CG-11	water	X	X	X	X	X	X	X		X	X		
CG12	water	X	X	X	X	X	X	X					
DM-1	water	X	X	X	X	X	X	X					

TABLE II: SAMPLE PLAN CHECKLIST
ANIMAS RIVER TARGETING PROJECT - CEMENT CREEK BASIN
Upper Cement Creek Basin and the Mainstem of Cement Creek

Sample Location	Sample Type	Field Parameter					Laboratory Parameters						
		Temp	pH	Cond	Flow	Fe2+/ Fe3+	Total Metals	Diss. Metals	Dup. Tot. Metals	Dup. Dis. Metals	Dup. Anions	Filtered Blank	Blank
DM-2	water	X	X	X	X	X	X	X					
DM-3	water	X	X	X	X	X	X	X					
DM-4	water	X	X	X	X	X	X	X					
DM-5	water	X	X	X	X	X	X	X					X
DM-6	water	X	X	X	X	X	X	X					
DM-7	water	X	X	X	X	X	X	X			X	X	X
DM-8	water	X	X	X	X	X	X	X					
DM-9	water	X	X	X	X	X	X	X					
DM-10	water	X	X	X	X	X	X	X			X		X
DM-11	water	X	X	X	X	X	X	X					
DM-12	water	X	X	X	X	X	X	X					
DM-13	water	X	X	X	X	X	X	X					
DM-14	water	X	X	X	X	X	X	X					
DM-15	water	X	X	X	X	X	X	X					
DM-16	water	X	X	X	X	X	X	X					

TABLE II: SAMPLE PLAN CHECKLIST
ANIMAS RIVER TARGETING PROJECT - CEMENT CREEK BASIN
Upper Cement Creek Basin and the Mainstem of Cement Creek

Sample Location	Sample Type	Field Parameter					Laboratory Parameters						
		Temp	pH	Cond	Flow	Fe2+/ Fe3+	Total Metals	Diss. Metals	Dup. Tot. Metals	Dup. Dis. Metals	Dup. Anions	Filtered Blank	Blank
DM-17	water	X	X	X	X	X	X	X					
DM-18	water	X	X	X	X	X	X	X					
DM-19	water	X	X	X	X	X	X	X	X	X			
DM-20	water	X	X	X	X	X	X	X					
DM-21	water	X	X	X	X	X	X	X					
DM-22	water	X	X	X	X	X	X	X					
DM-23	water	X	X	X	X	X	X	X					
DM-24	water	X	X	X	X	X	X	X					
HC-1	water	X	X	X	X	X	X	X					
PL-1	water	X	X	X	X	X	X	X					
CN-1	water	X	X	X	X	X	X	X					
GG-1	water	X	X	X	X	X	X	X					
PY-1	water	X	X	X	X	X	X	X					
BU-1	water	X	X	X	X	X	X	X					
NG-1	water	X	X	X	X	X	X	X					

TABLE III - TARGET COMPOUND LIST
ANIMAS RIVER TARGETING PROJECT
Upper Animas River Basin

Variable, Units	Method	Holding Time	Reporting Limits
Aluminum, ug/l	EPA 200.7	six months	50 ug/l
Antimony, ug/l	EPA 200.7	six months	60 ug/l
Arsenic, ug/l	EPA 200.7	six months	10 ug/l
Barium, ug/l	EPA 200.7	six months	200 ug/l
Beryllium, ug/l	EPA 200.7	six months	5 ug/l
Cadmium, ug/l	EPA 200.9	six months	0.5 ug/l
Calcium, ug/l	EPA 200.7	six months	1000 ug/l
Chloride, ug/l	EPA 300.0	28 days	1000 ug/l
Chromium, ug/l	EPA 200.7	six months	10 ug/l
Cobalt, ug/l	EPA 200.7	six months	50 ug/l
Copper, ug/l	EPA 200.7	six months	4 ug/l
Iron, ug/l	EPA 200.7	six months	10 ug/l
Lead, ug/l	EPA 200.9	six months	5 ug/l
Magnesium, ug/l	EPA 200.7	six months	1000 ug/l
Manganese, ug/l	EPA 200.7	six months	4 ug/l
Nickel, ug/l	EPA 200.7	six months	20 ug/l
Potassium, ug/l	EPA 200.7	six months	1000 ug/l
Selenium, ug/l	EPA 200.9	six months	1 ug/l
Silica, ug/l	EPA 370.1	six months	2000 ug/l
Silver, ug/l	EPA 200.9	six months	0.2 ug/l
Sodium, ug/l	EPA 200.7	six months	1000 ug/l
Sulfate, ug/l	EPA 300.0	28 days	1000 ug/l
Thallium, ug/l	EPA 200.9	six months	10 ug/l
Vanadium, ug/l	EPA 200.7	six months	50 ug/l
Zinc, ug/l	EPA 200.7	six months	8 ug/l

TABLE IV
SAMPLE PRESERVATION AND BOTTLE REQUIREMENTS
Animas River Targeting Project
Upper Animas River Basin

AQUEOUS SAMPLES (36 surface water locations, 24 mine drainage samples and 6 QA/QC samples)

Analysis	Samples	Container/Collection /Preservation
Total Metals	66	(1) 250 ml poly/2m/HNO3
Dissolved Metals	66	(1) 250 ml poly/Field Filter/1m/HNO3
Anions/Cations	66	(1) 250 ml poly/neutral

*All samples will be cooled to 4° C upon collection.

TABLE II: SAMPLE PLAN CHECKLIST
ANIMAS RIVER TARGETING PROJECT - CEMENT CREEK BASIN
Upper Cement Creek Basin and the Mainstem of Cement Creek

Sample Location	Sample Type	Field Parameter					Laboratory Parameters						
		Temp	pH	Cond	Flow	Fe2+/ Fe3+	Total Metals	Diss. Metals	Dup. Tot. Metals	Dup. Dis. Metals	Dup. Anions	Filtered Blank	Blank
UA-1	water	X	X	X	X	X	X	X				X	X
UA-2	water	X	X	X	X	X	X	X					
UA-3	water	X	X	X	X	X	X	X					
UA-4	water	X	X	X	X	X	X	X					
UA-5	water	X	X	X	X	X	X	X					
UA-6	water	X	X	X	X	X	X	X	X				
UA-7	water	X	X	X	X	X	X	X				X	X
UA-8	water	X	X	X	X	X	X	X					
UA-9	water	X	X	X	X	X	X	X					
UA-10	water	X	X	X	X	X	X	X					
UA-11	water	X	X	X	X	X	X	X					
UA-12	water	X	X	X	X	X	X	X	X	X			
BG-1	water	X	X	X	X	X	X	X					
BG-2	water	X	X	X	X	X	X	X					
BG-3	water	X	X	X	X	X	X	X					

TABLE II: SAMPLE PLAN CHECKLIST
ANIMAS RIVER TARGETING PROJECT - CEMENT CREEK BASIN
Upper Cement Creek Basin and the Mainstem of Cement Creek

Sample Location	Sample Type	Field Parameter					Laboratory Parameters						
		Temp	pH	Cond	Flow	Fe2+/ Fe3+	Total Metals	Diss. Metals	Dup. Tot. Metals	Dup. Dis. Metals	Dup. Anions	Filtered Blank	Blank
BG-4	water	X	X	X	X	X	X	X					
BG-5	water	X	X	X	X	X	X	X					
CG-1	water	X	X	X	X	X	X	X					
CG-2	water	X	X	X	X	X	X	X					X
CG-3	water	X	X	X	X	X	X	X					
CG-4	water	X	X	X	X	X	X	X					
CG-5	water	X	X	X	X	X	X	X					
CG-6	water	X	X	X	X	X	X	X					
CG-7	water	X	X	X	X	X	X	X					
CG-8	water	X	X	X	X	X	X	X					
CG-9	water	X	X	X	X	X	X	X					
CG-10	water	X	X	X	X	X	X	X					
CG-11	water	X	X	X	X	X	X	X		X	X		
CG12	water	X	X	X	X	X	X	X					
DM-1	water	X	X	X	X	X	X	X					

TABLE II: SAMPLE PLAN CHECKLIST
ANIMAS RIVER TARGETING PROJECT - CEMENT CREEK BASIN
Upper Cement Creek Basin and the Mainstem of Cement Creek
Page 3 of 4 Pages

Sample Location	Sample Type	Field Parameter					Laboratory Parameters						
		Temp	pH	Cond	Flow	Fe2+/ Fe3+	Total Metals	Diss. Metals	Dup. Tot. Metals	Dup. Dis. Metals	Dup. Anions	Filtered Blank	Blank
DM-2	water	X	X	X	X	X	X	X					
DM-3	water	X	X	X	X	X	X	X					
DM-4	water	X	X	X	X	X	X	X					
DM-5	water	X	X	X	X	X	X	X					X
DM-6	water	X	X	X	X	X	X	X					
DM-7	water	X	X	X	X	X	X	X			X	X	X
DM-8	water	X	X	X	X	X	X	X					
DM-9	water	X	X	X	X	X	X	X					
DM-10	water	X	X	X	X	X	X	X			X		X
DM-11	water	X	X	X	X	X	X	X					
DM-12	water	X	X	X	X	X	X	X					
DM-13	water	X	X	X	X	X	X	X					
DM-14	water	X	X	X	X	X	X	X					
DM-15	water	X	X	X	X	X	X	X					
DM-16	water	X	X	X	X	X	X	X					

TABLE II: SAMPLE PLAN CHECKLIST
ANIMAS RIVER TARGETING PROJECT - CEMENT CREEK BASIN
Upper Cement Creek Basin and the Mainstem of Cement Creek

Sample Location	Sample Type	Field Parameter					Laboratory Parameters						
		Temp	pH	Cond	Flow	Fe2+/ Fe3+	Total Metals	Diss. Metals	Dup. Tot. Metals	Dup. Dis. Metals	Dup. Anions	Filtered Blank	Blank
DM-17	water	X	X	X	X	X	X	X					
DM-18	water	X	X	X	X	X	X	X					
DM-19	water	X	X	X	X	X	X	X	X	X			
DM-20	water	X	X	X	X	X	X	X					
DM-21	water	X	X	X	X	X	X	X					
DM-22	water	X	X	X	X	X	X	X					
DM-23	water	X	X	X	X	X	X	X					
DM-24	water	X	X	X	X	X	X	X					
HC-1	water	X	X	X	X	X	X	X					
PL-1	water	X	X	X	X	X	X	X					
CN-1	water	X	X	X	X	X	X	X					
GG-1	water	X	X	X	X	X	X	X					
PY-1	water	X	X	X	X	X	X	X					
BU-1	water	X	X	X	X	X	X	X					
NG-1	water	X	X	X	X	X	X	X					

TABLE III - TARGET COMPOUND LIST
ANIMAS RIVER TARGETING PROJECT
Upper Animas River Basin

Variable, Units	Method	Holding Time	Reporting Limits
Aluminum, ug/l	EPA 200.7	six months	50 ug/l
Antimony, ug/l	EPA 200.7	six months	60 ug/l
Arsenic, ug/l	EPA 200.7	six months	10 ug/l
Barium, ug/l	EPA 200.7	six months	200 ug/l
Beryllium, ug/l	EPA 200.7	six months	5 ug/l
Cadmium, ug/l	EPA 200.9	six months	0.5 ug/l
Calcium, ug/l	EPA 200.7	six months	1000 ug/l
Chloride, ug/l	EPA 300.0	28 days	1000 ug/l
Chromium, ug/l	EPA 200.7	six months	10 ug/l
Cobalt, ug/l	EPA 200.7	six months	50 ug/l
Copper, ug/l	EPA 200.7	six months	4 ug/l
Iron, ug/l	EPA 200.7	six months	10 ug/l
Lead, ug/l	EPA 200.9	six months	5 ug/l
Magnesium, ug/l	EPA 200.7	six months	1000 ug/l
Manganese, ug/l	EPA 200.7	six months	4 ug/l
Nickel, ug/l	EPA 200.7	six months	20 ug/l
Potassium, ug/l	EPA 200.7	six months	1000 ug/l
Selenium, ug/l	EPA 200.9	six months	1 ug/l
Silica, ug/l	EPA 370.1	six months	2000 ug/l
Silver, ug/l	EPA 200.9	six months	0.2 ug/l
Sodium, ug/l	EPA 200.7	six months	1000 ug/l
Sulfate, ug/l	EPA 300.0	28 days	1000 ug/l
Thallium, ug/l	EPA 200.9	six months	10 ug/l
Vanadium, ug/l	EPA 200.7	six months	50 ug/l
Zinc, ug/l	EPA 200.7	six months	8 ug/l

TABLE IV
SAMPLE PRESERVATION AND BOTTLE REQUIREMENTS
Animas River Targeting Project
Upper Animas River Basin

AQUEOUS SAMPLES (36 surface water locations, 24 mine drainage samples and 6 QA/QC samples)

Analysis	Samples	Container/Collection /Preservation
Total Metals	66	(1) 250 ml poly/2m/HNO_3
Dissolved Metals	66	(1) 250 ml poly/Field Filter/1m/HNO_3
Anions/Cations	66	(1) 250 ml poly/neutral

*All samples will be cooled to 4° C upon collection.